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(12) **United States Patent**
Votel

(10) **Patent No.: US 6,341,393 B1**
(45) **Date of Patent: Jan. 29, 2002**

(54) **PATIENT TRANSFER AND REPOSITIONING SYSTEM**

(75) Inventor: **Thomas W. Votel**, Saint Paul, MN (US)

(73) Assignee: **Ergodyne Corporation**, Saint Paul, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/174,110**

(22) Filed: **Oct. 17, 1998**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/057,139, filed on Apr. 8, 1998, which is a continuation-in-part of application No. 08/713,412, filed on Sep. 13, 1996, now Pat. No. 5,890,238, which is a continuation-in-part of application No. 08/527,519, filed on Sep. 13, 1995, now Pat. No. 5,737,781.

(60) Provisional application No. 60/043,208, filed on Apr. 8, 1997, provisional application No. 60/084,519, filed on May 7, 1998, provisional application No. 60/092,286, filed on Jul. 10, 1998, and provisional application No. 60/092,287, filed on Jul. 10, 1998.

(51) **Int. Cl.**[7] **A61G 7/10**; A47G 9/02

(52) **U.S. Cl.** ..... **5/81.1 T**; 5/81.1 HS; 5/89.1; 5/484; 5/502

(58) **Field of Search** ..... 5/81.1 R, 88.1, 5/89.1, 81.1 T, 81.1 C, 81.1 HS, 502, 424, 487, 484

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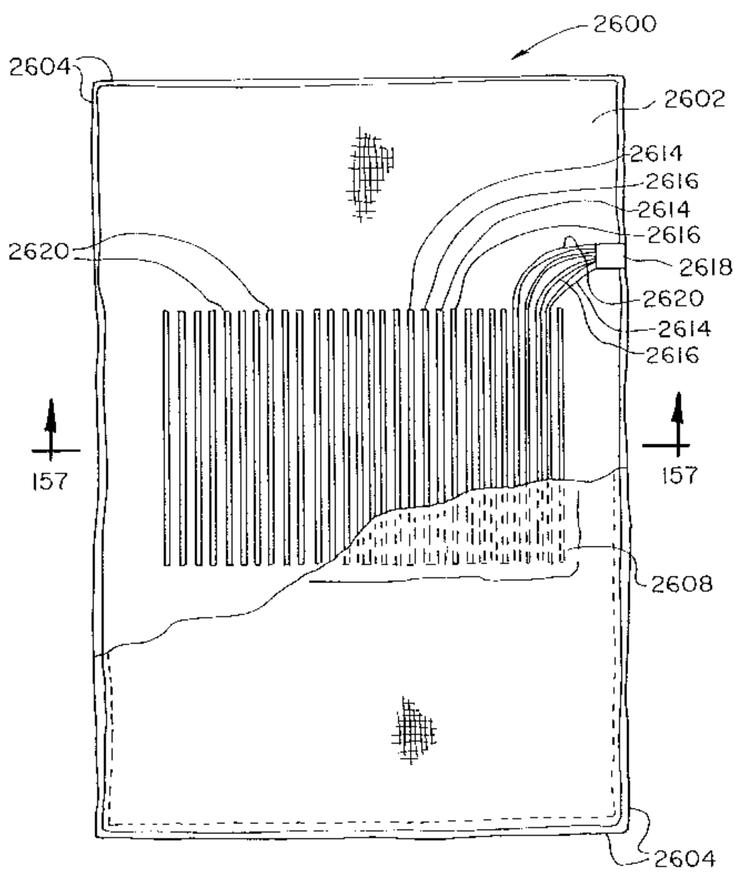
Primary Examiner—Lynne H. Browne
Assistant Examiner—Robert G. Santos
(74) *Attorney, Agent, or Firm*—Patterson, Thuente, Skaar & Christensen, PA

(57) **ABSTRACT**

Apparatus including a substantially pliable underlayment, connecting member, and means to exert a force to transfer or reposition a patient is provided. The substantially pliable underlayment includes a substantially smooth mantle, an attaching structure operably adjacent the mantle, and a reinforcing structure for imparting resistance to mantle distortion during transfer or repositioning. The attaching structure includes a reinforced beaded edge and an attaching structure cooperating with the mantle to form a pocket accommodating a transfer bar. The reinforcing structure includes stitching disposed generally diagonally in the mantle and reinforcing fibers present in the material of the mantle. A method of using the pliable underlayment to transfer or reposition a patient is also provided.

49 Claims, 62 Drawing Sheets



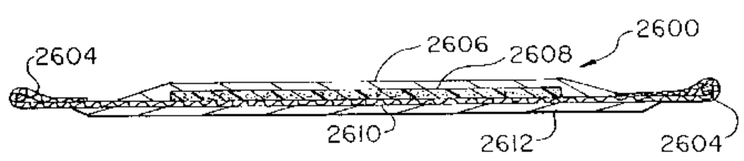


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Fig. 1

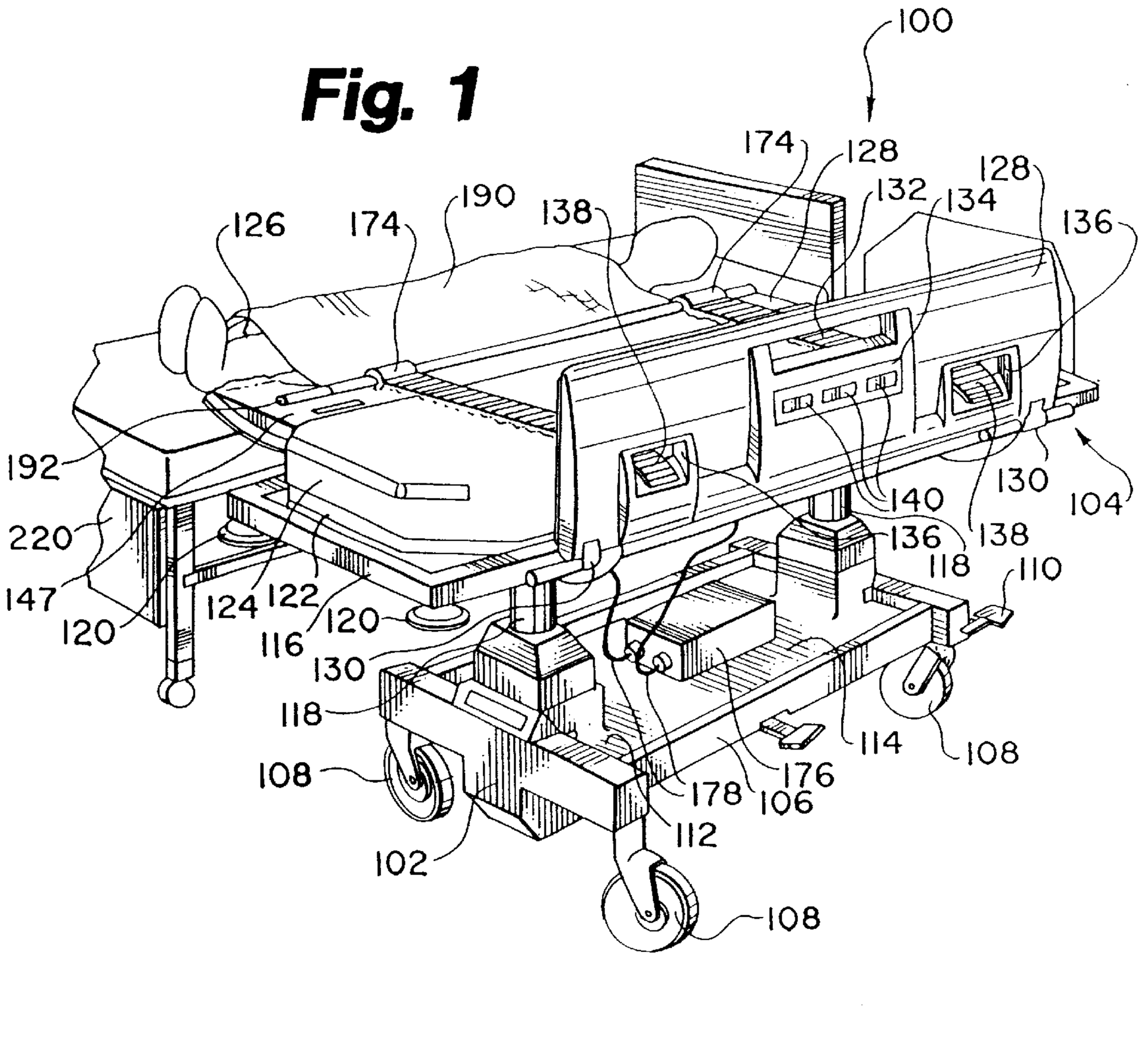
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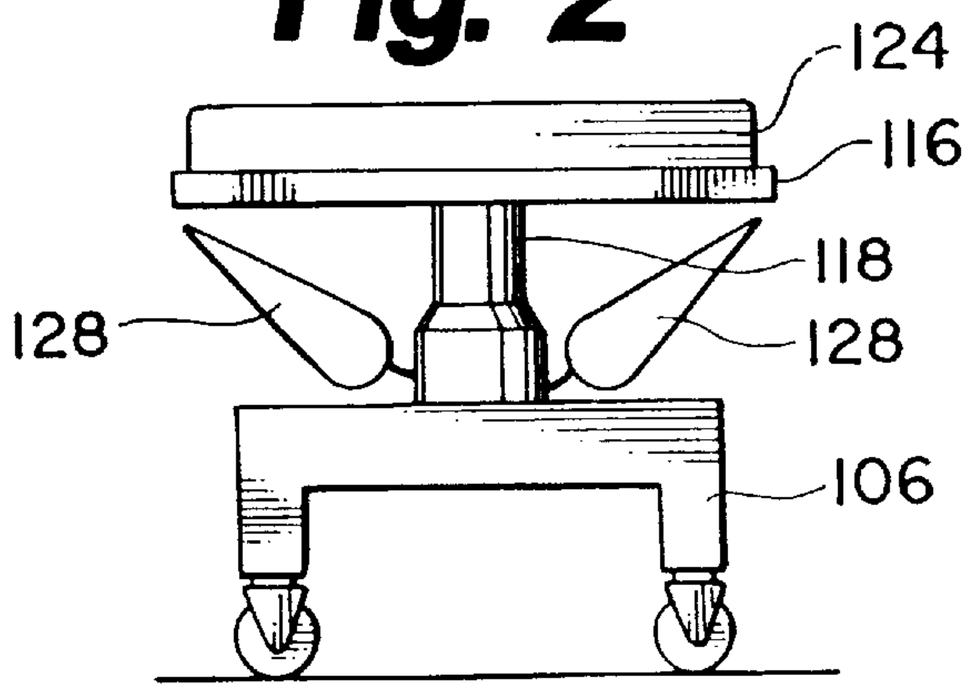
Fig. 2



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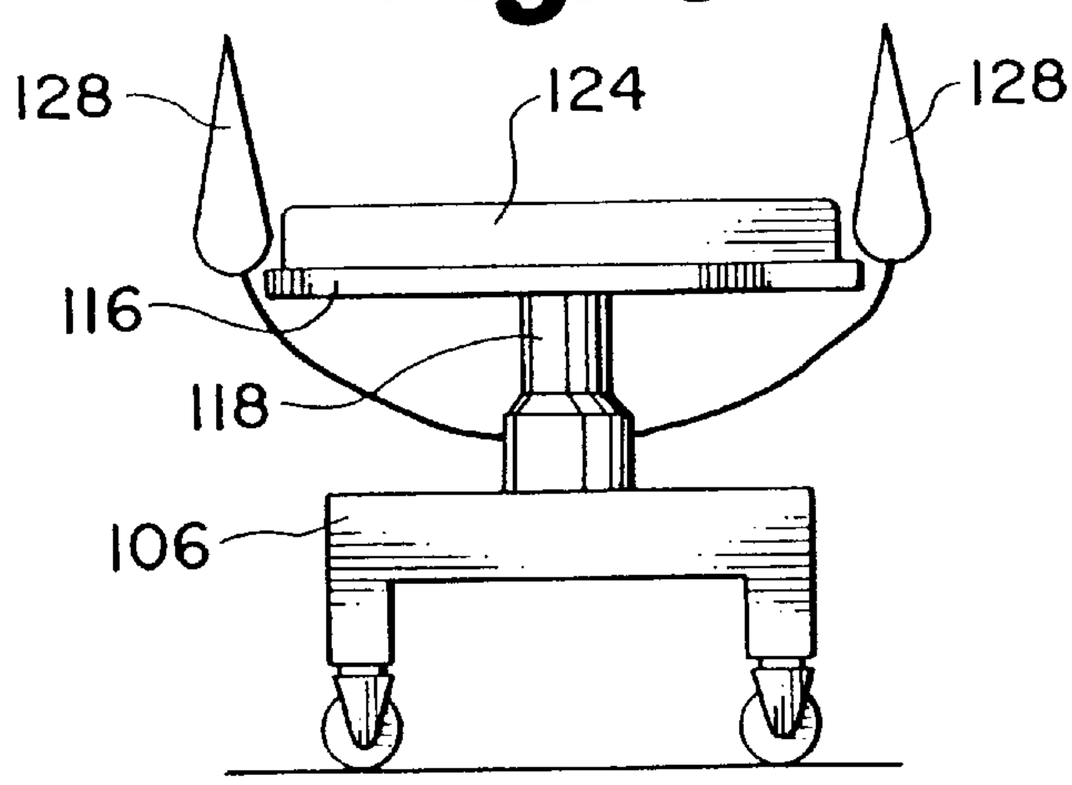

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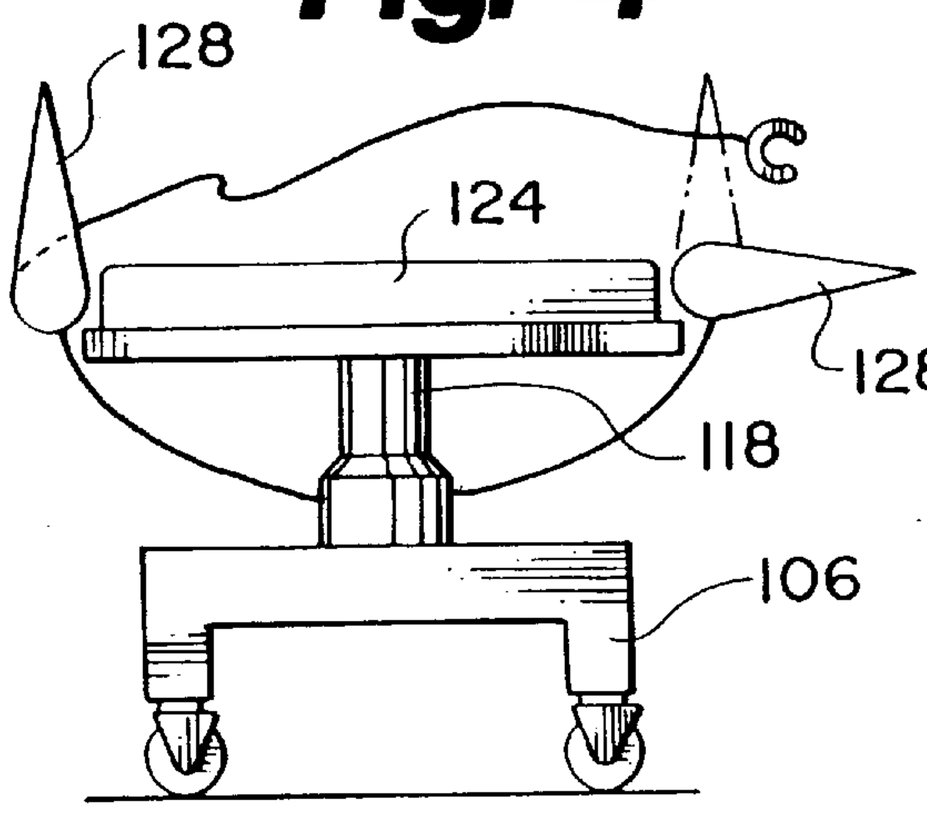

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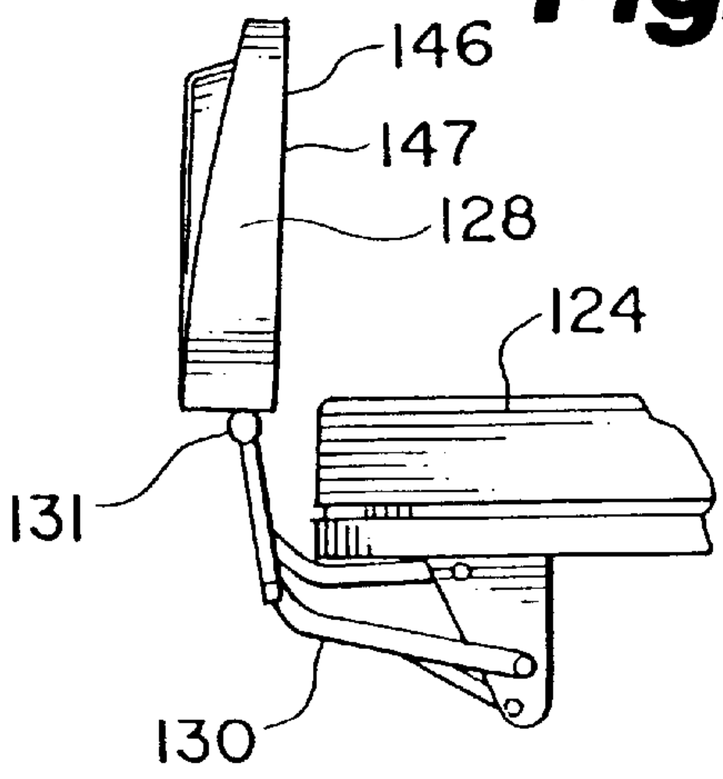

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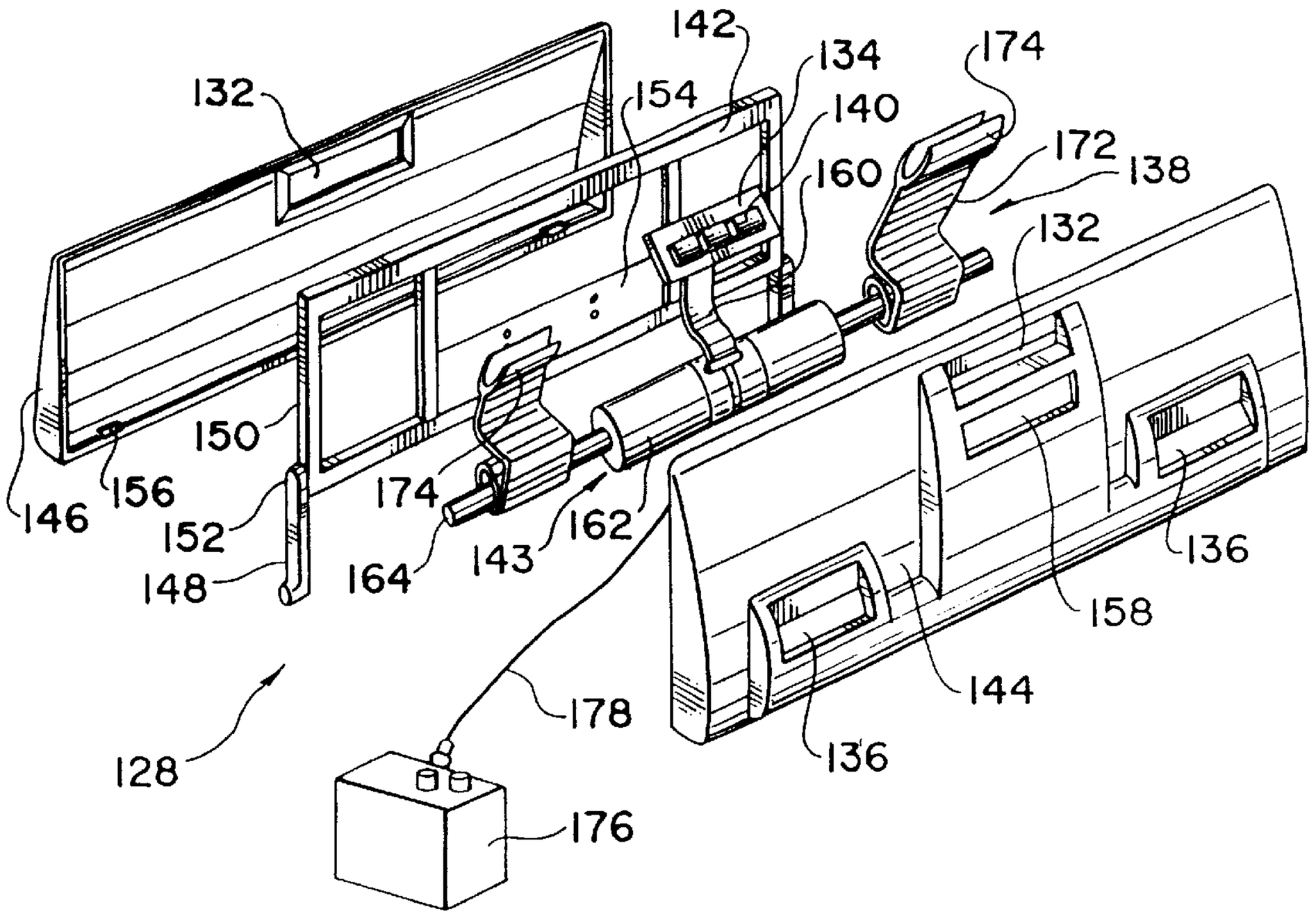
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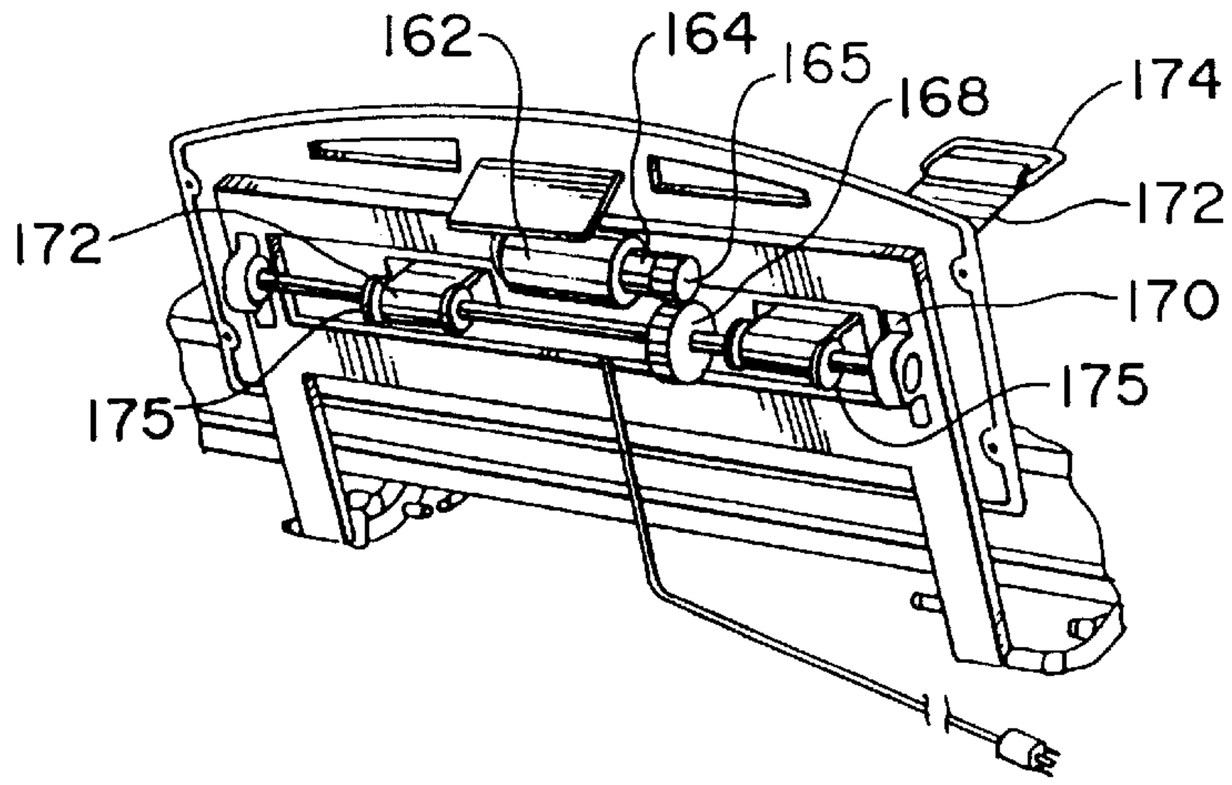
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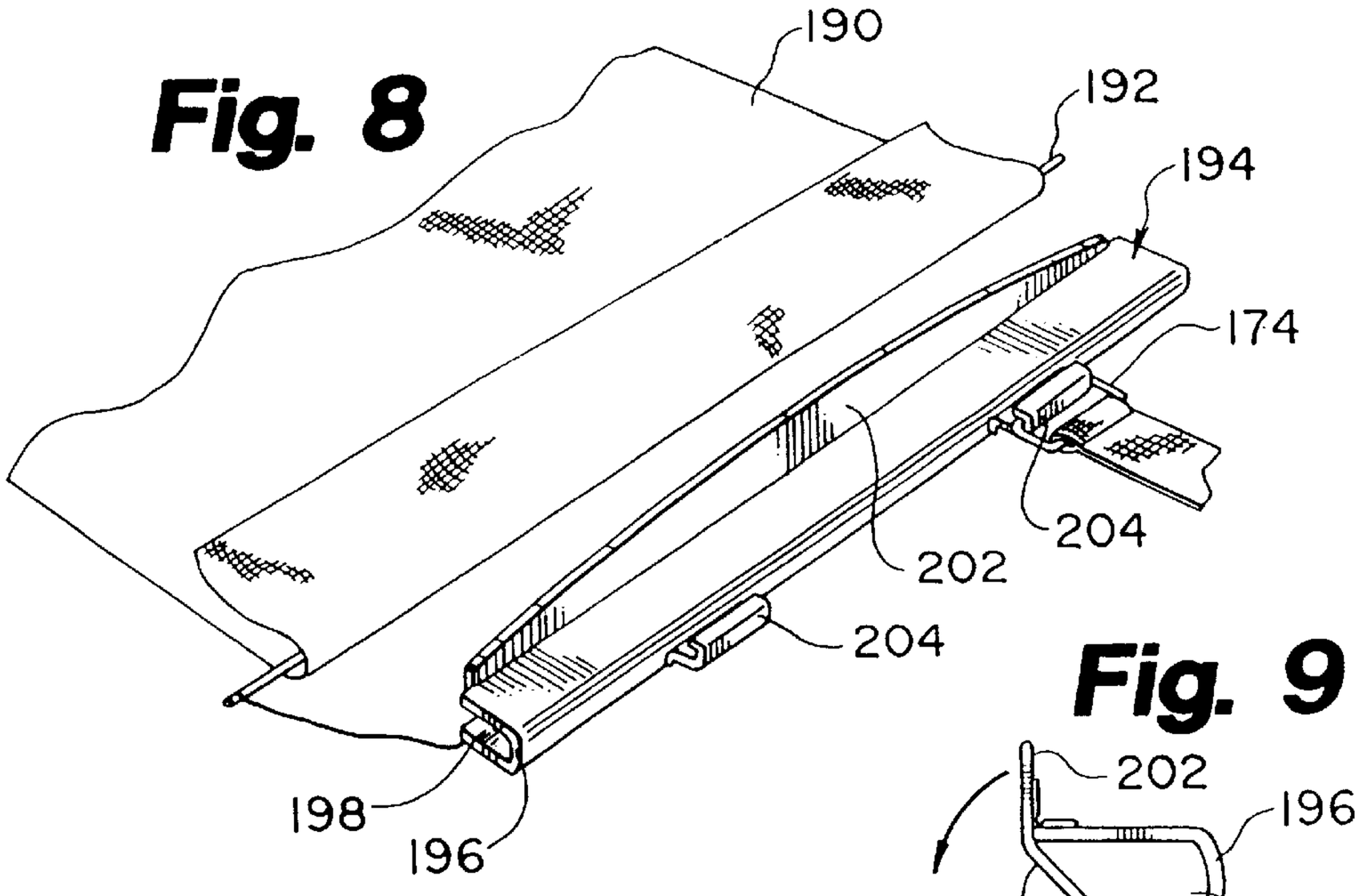

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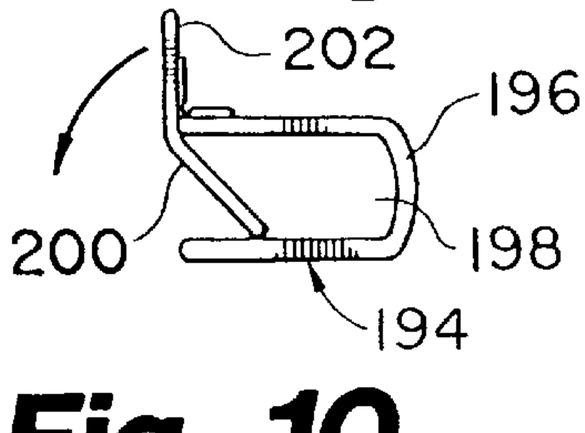

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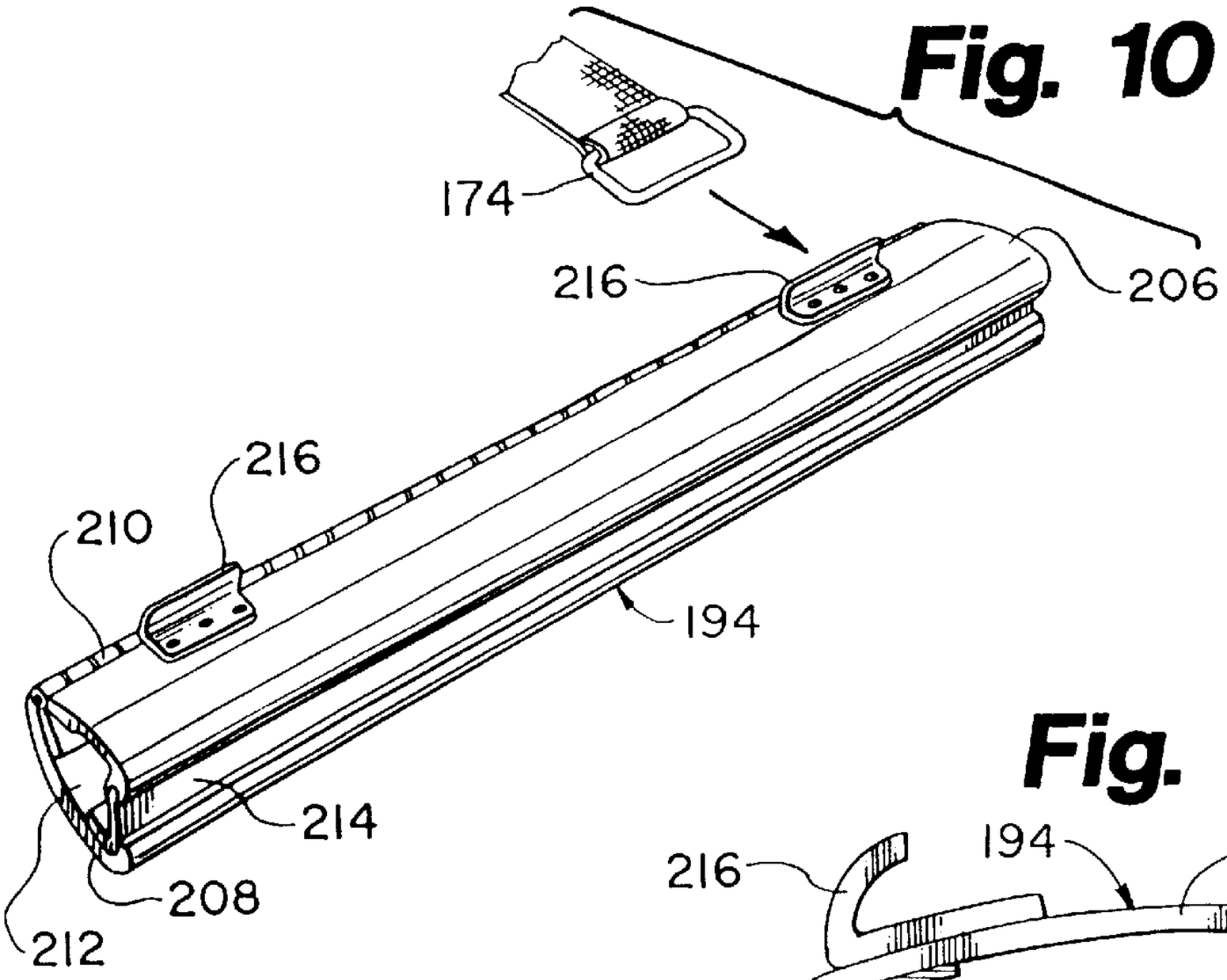

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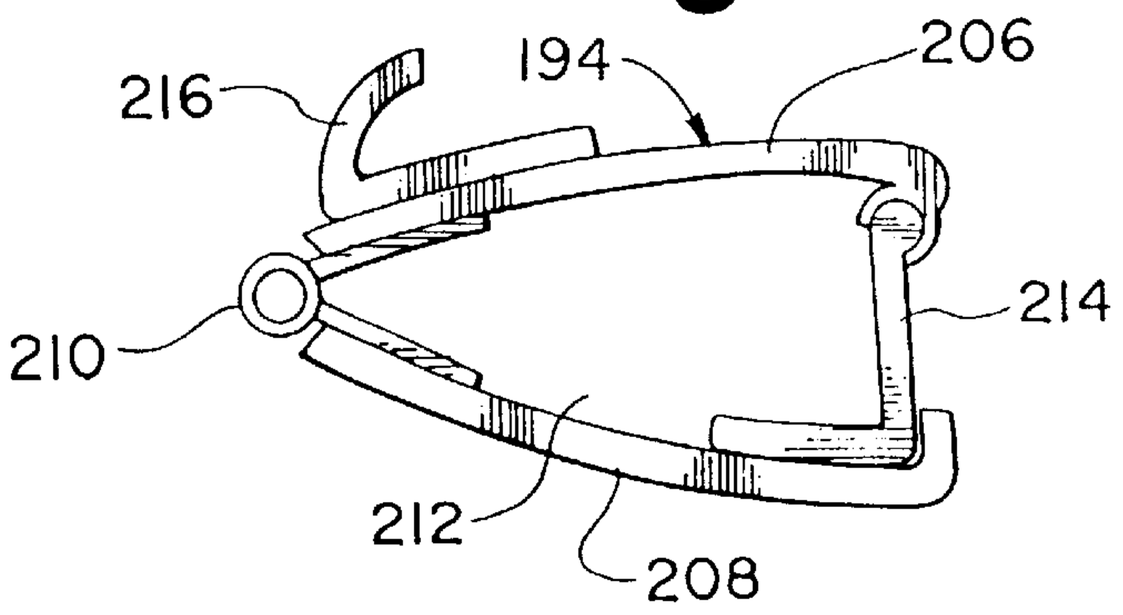

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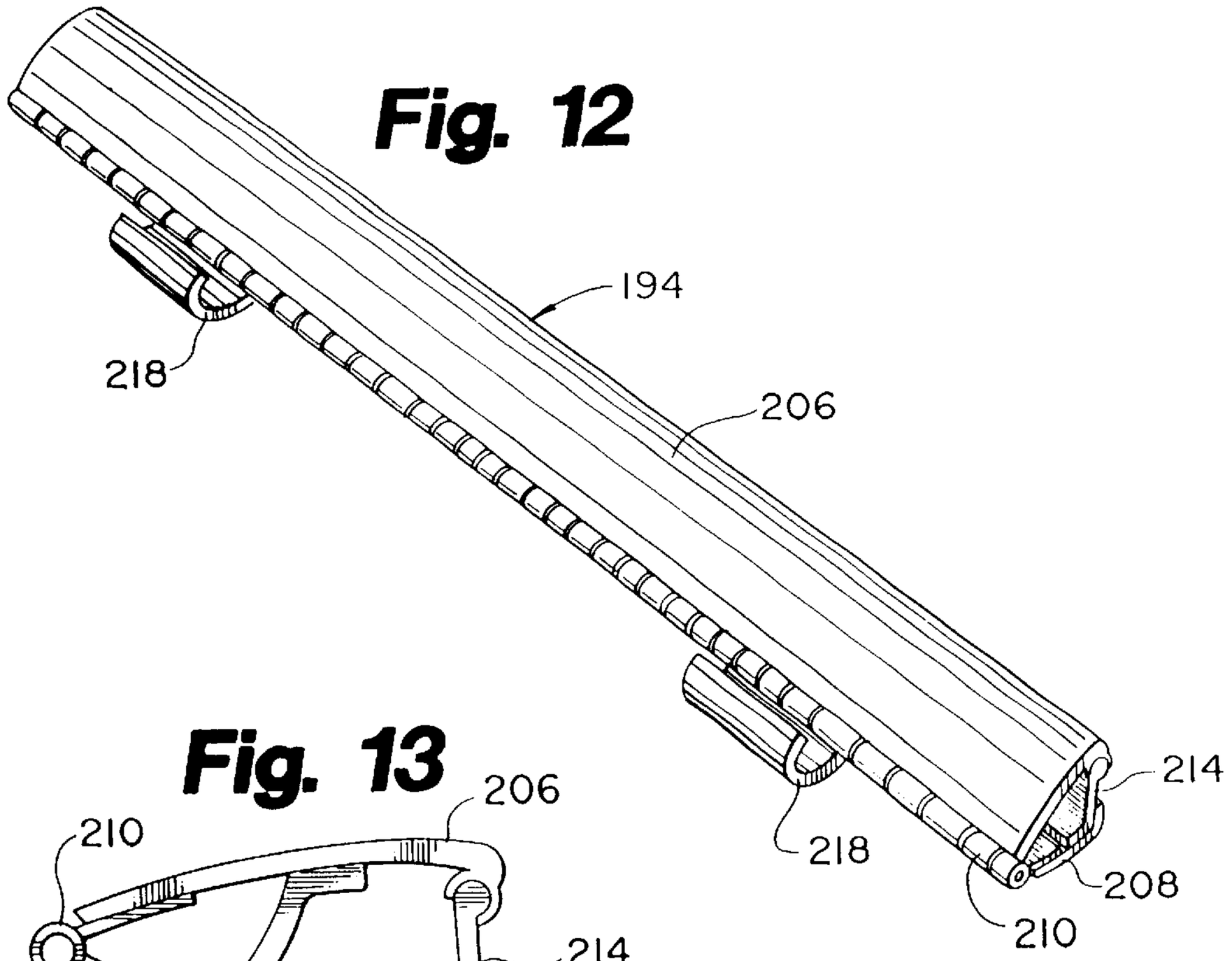

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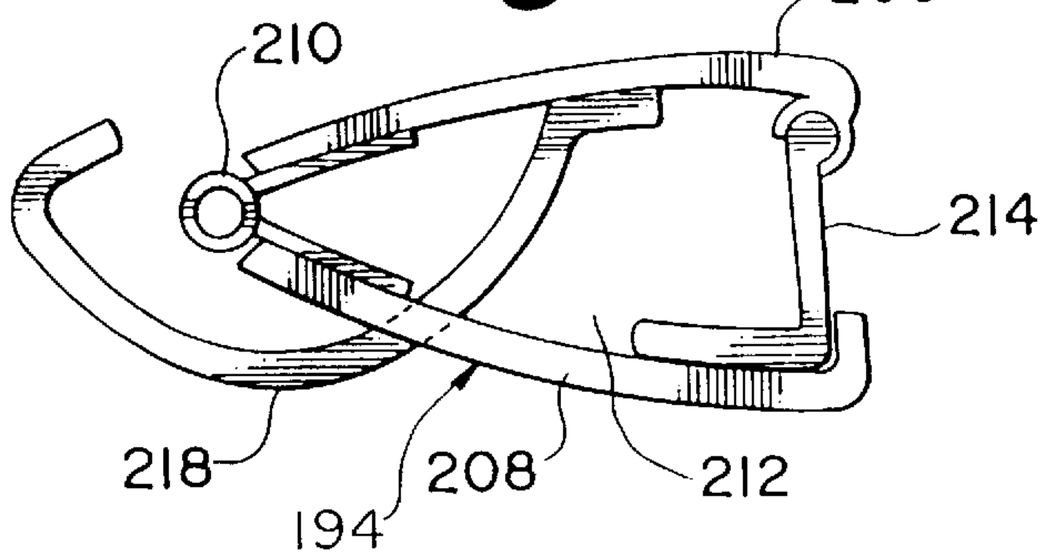

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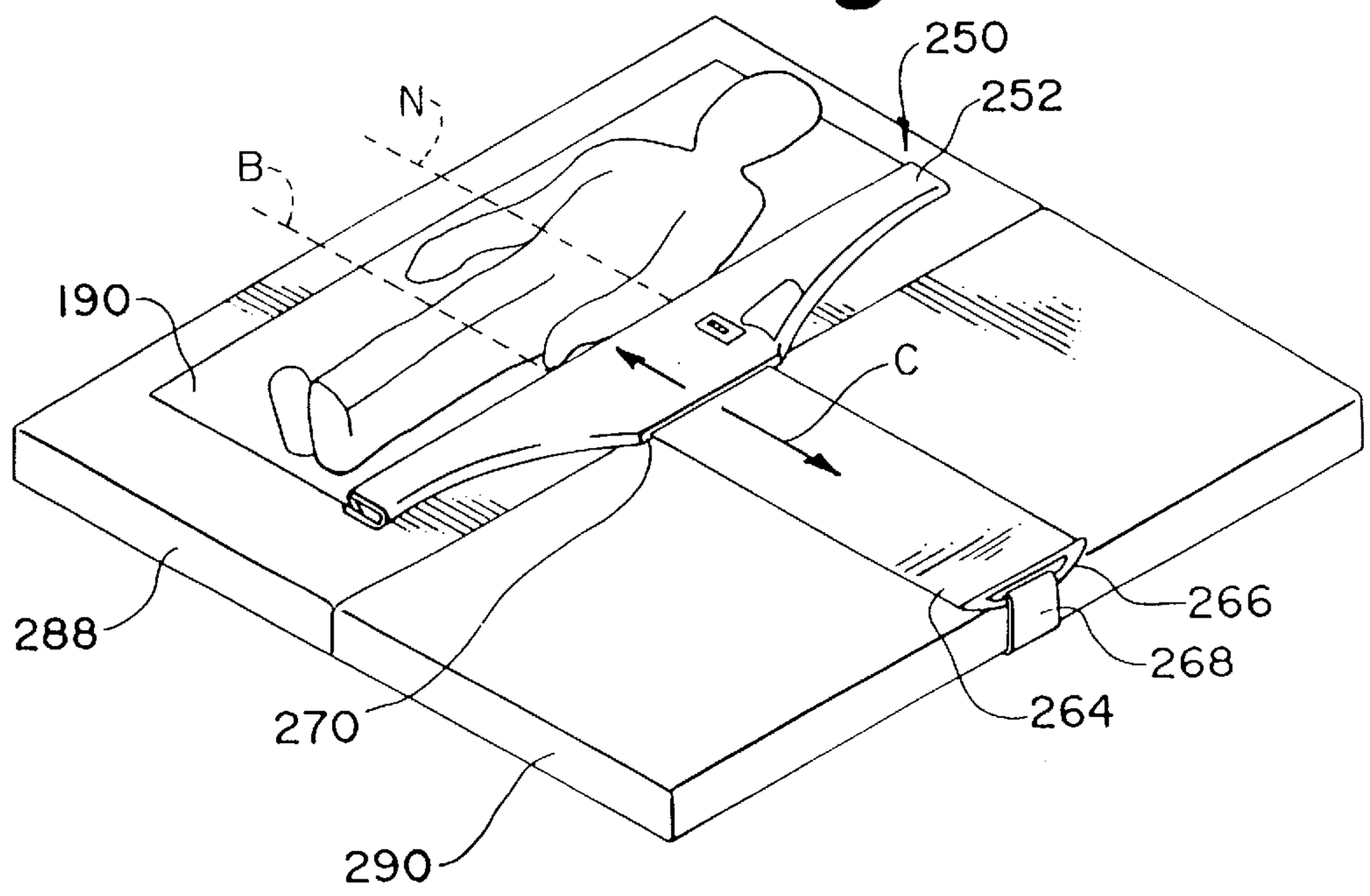

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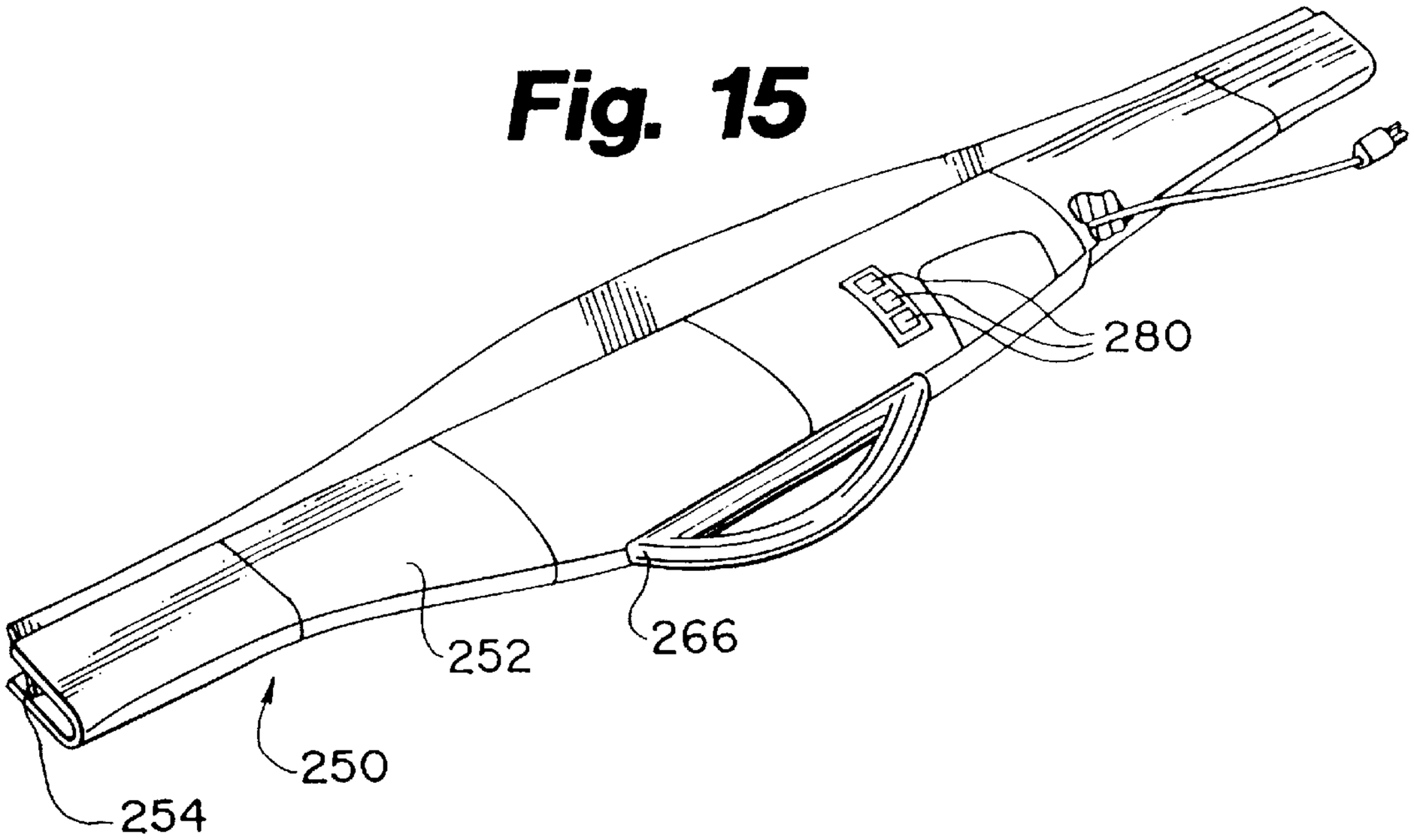
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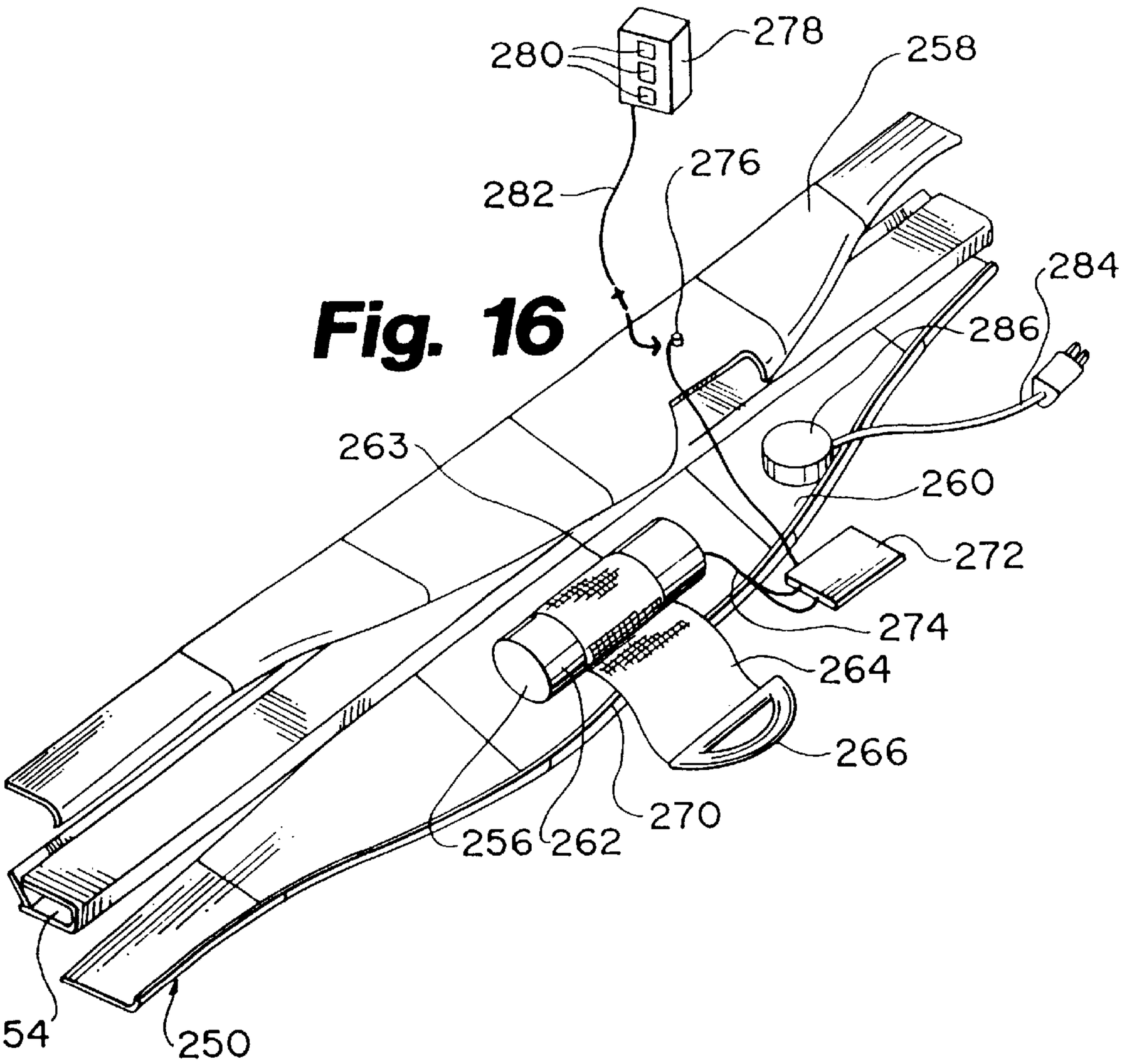
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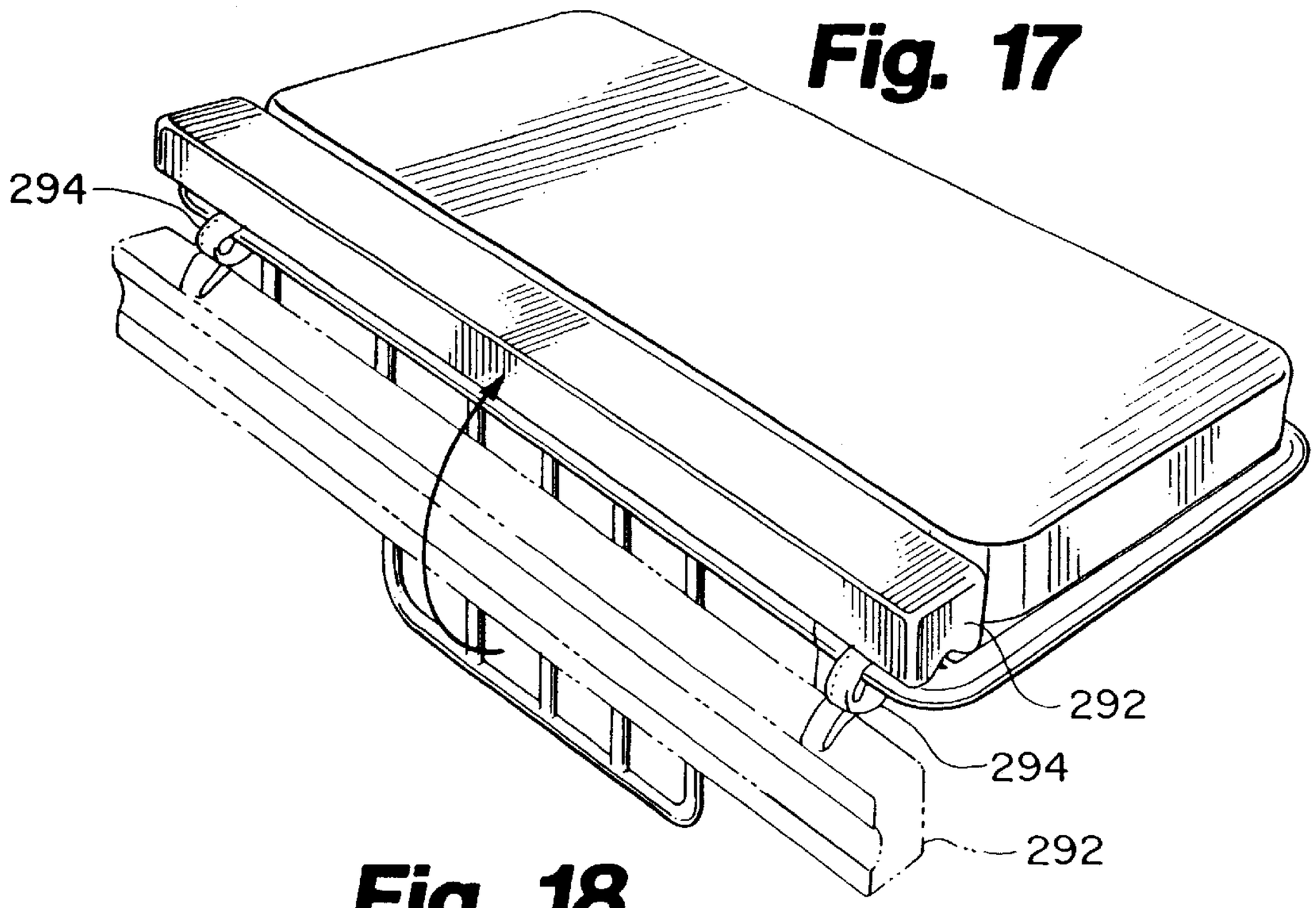
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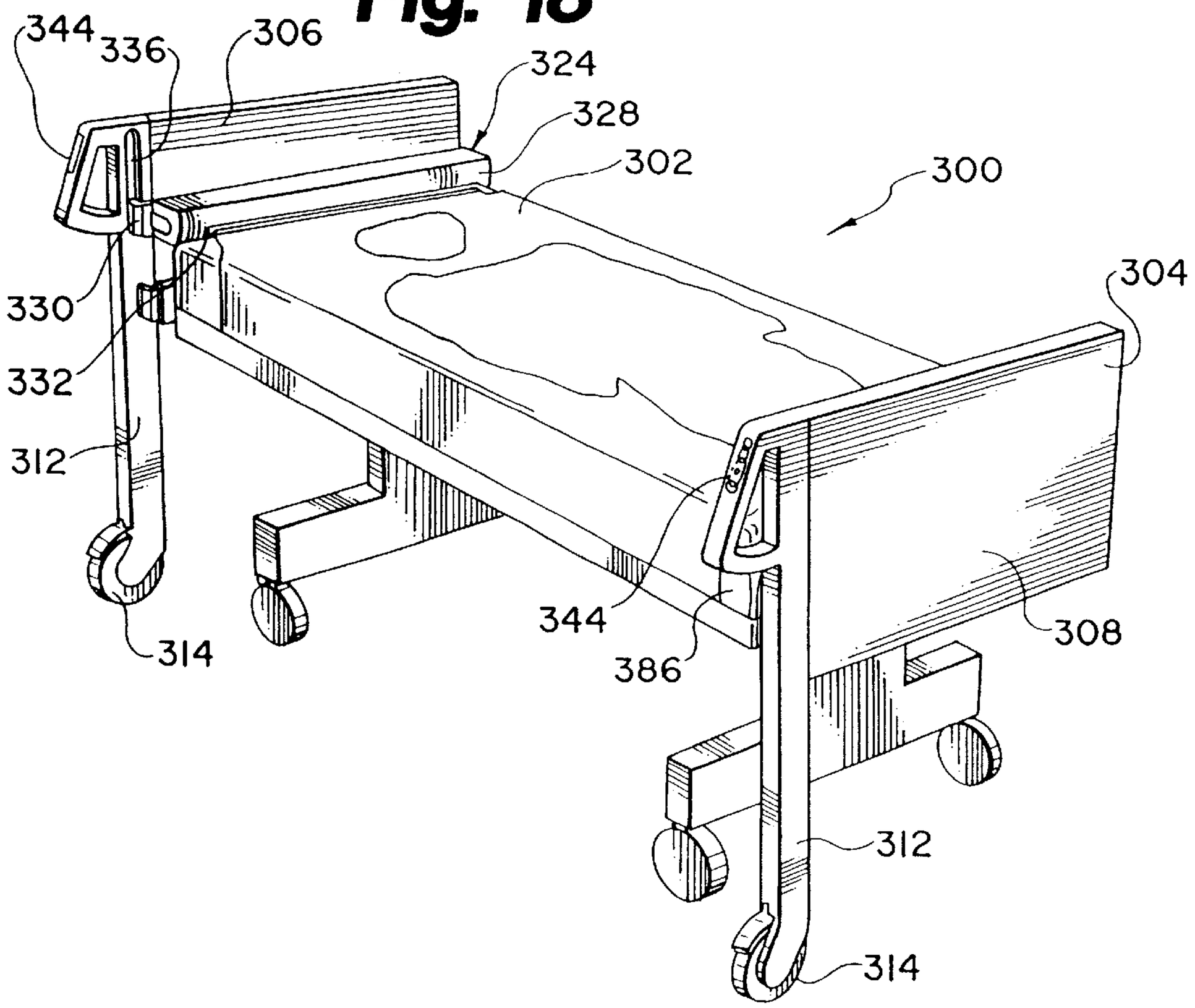
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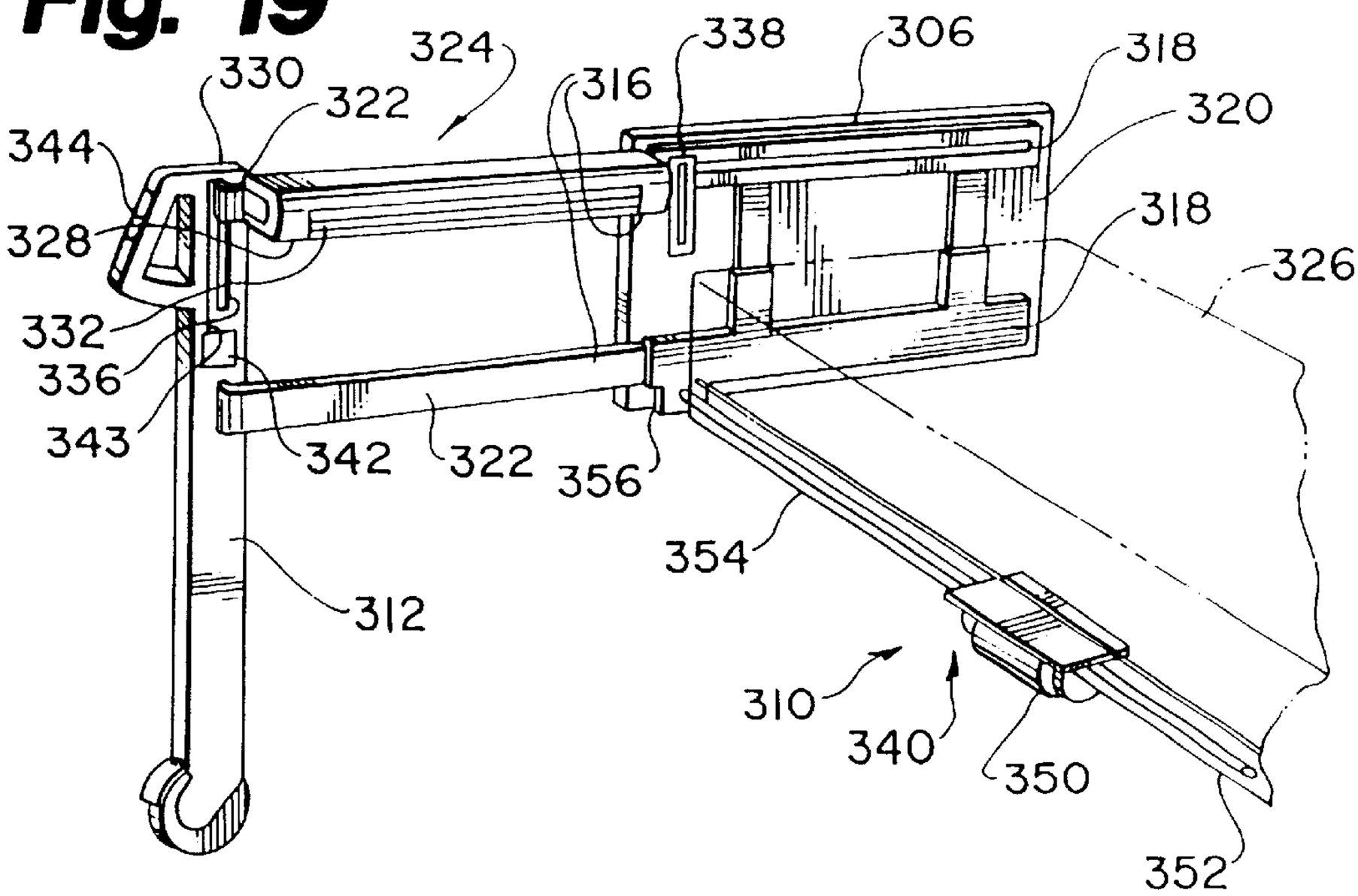
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Fig. 20

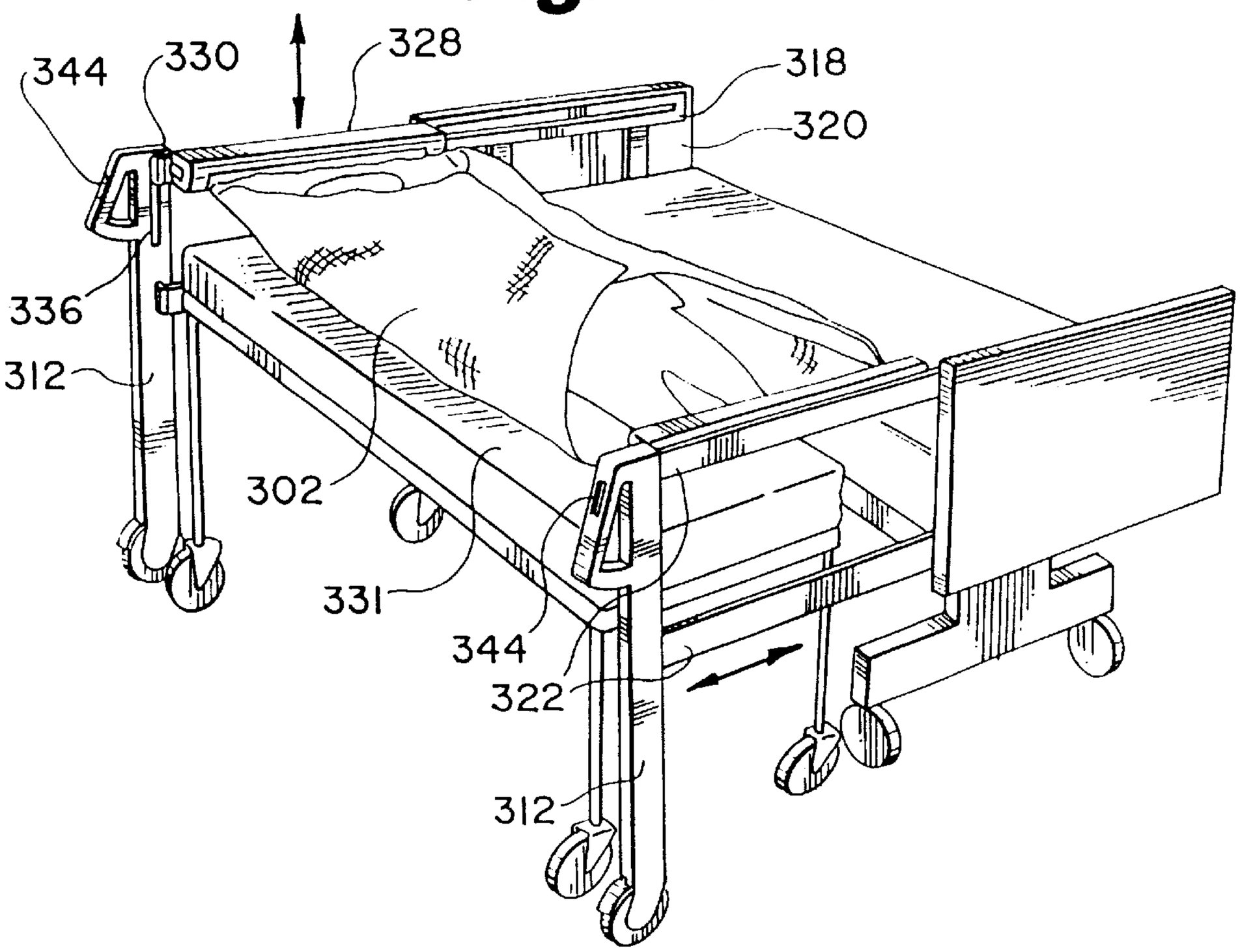
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Fig. 21

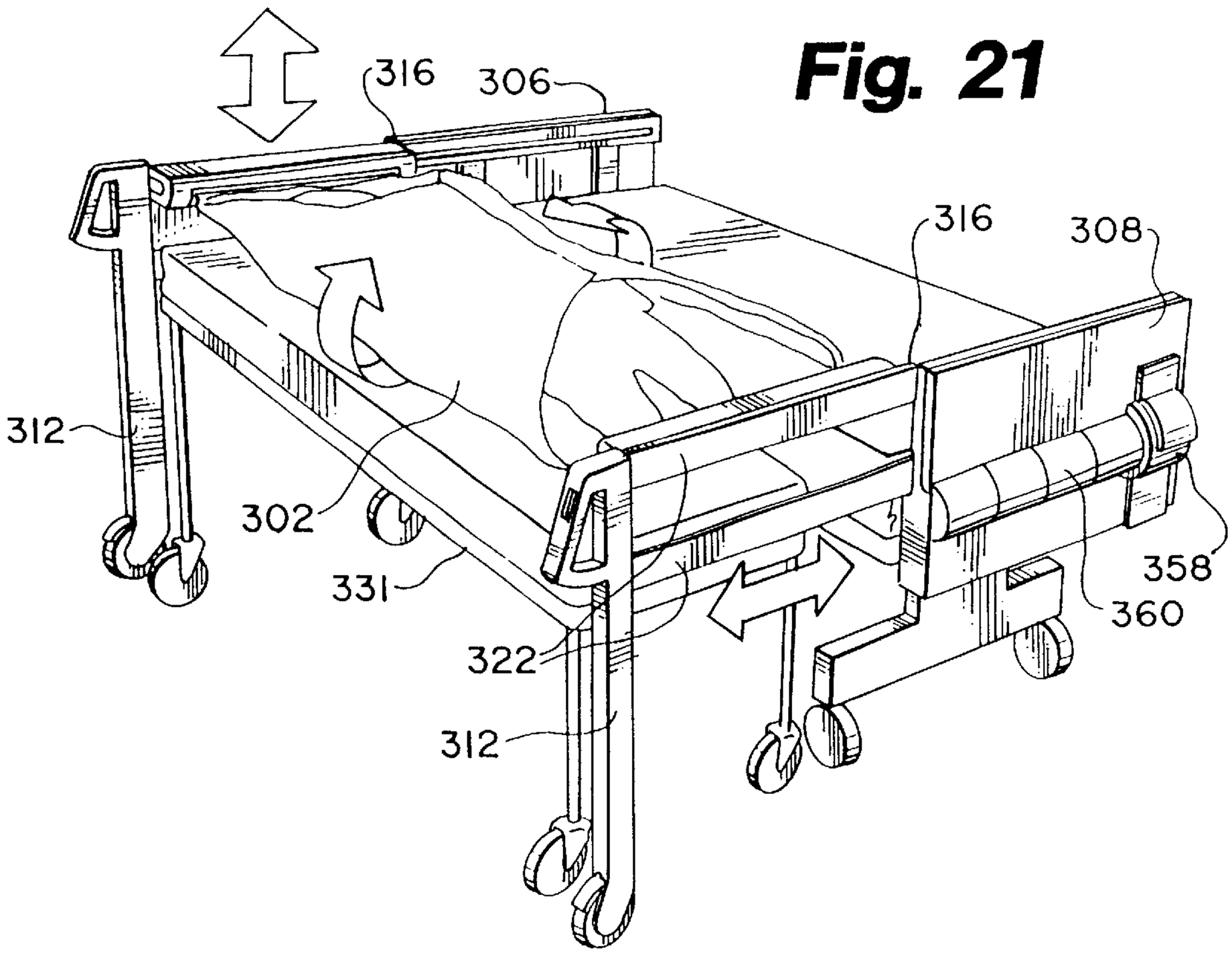
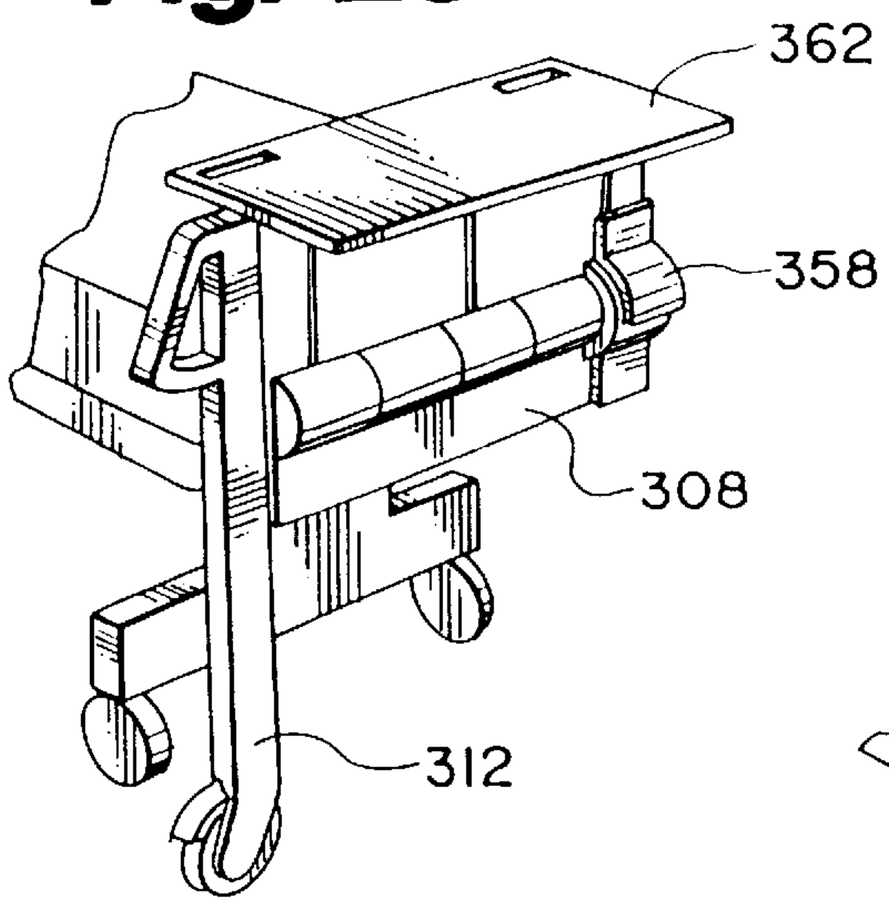


Fig. 25



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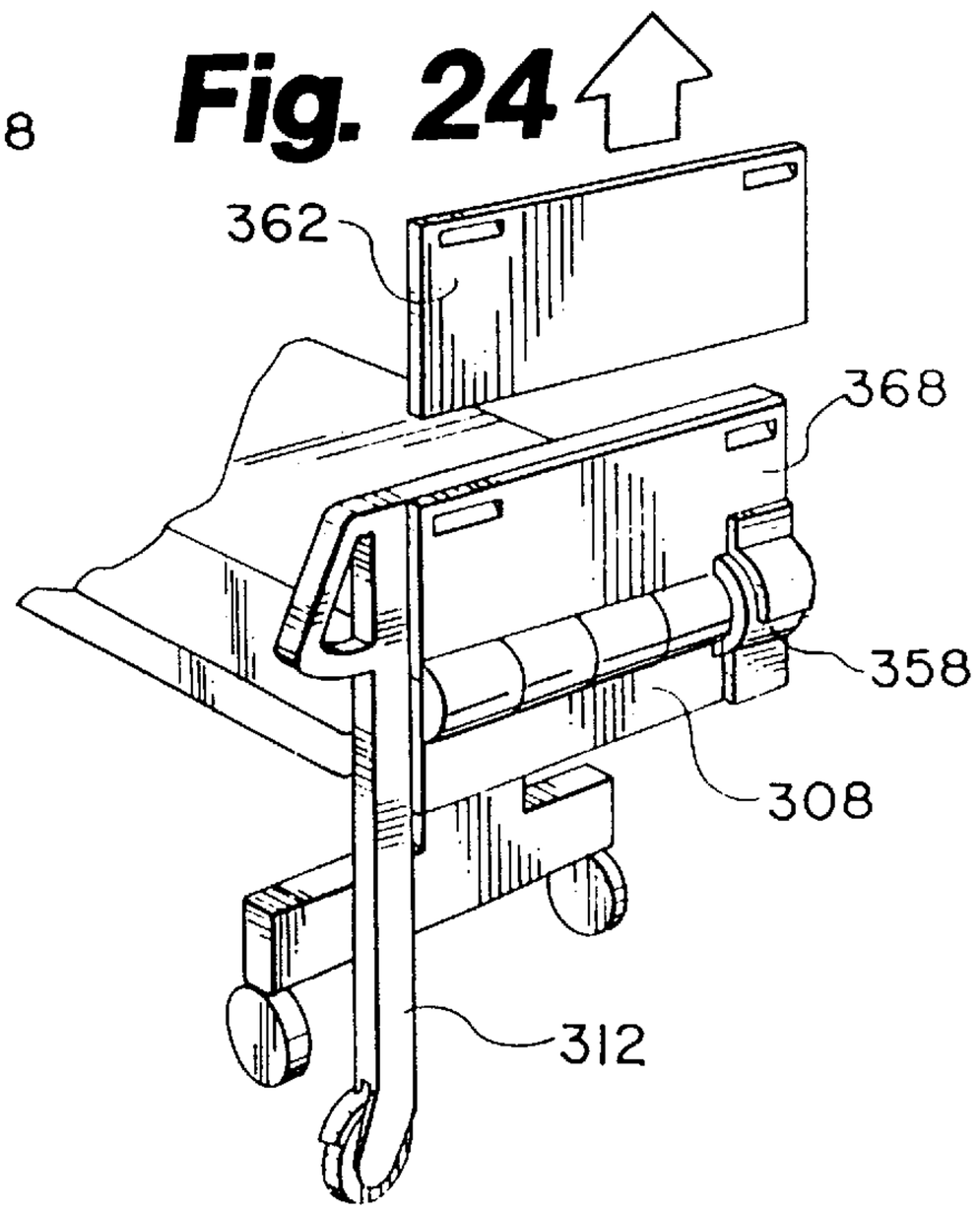

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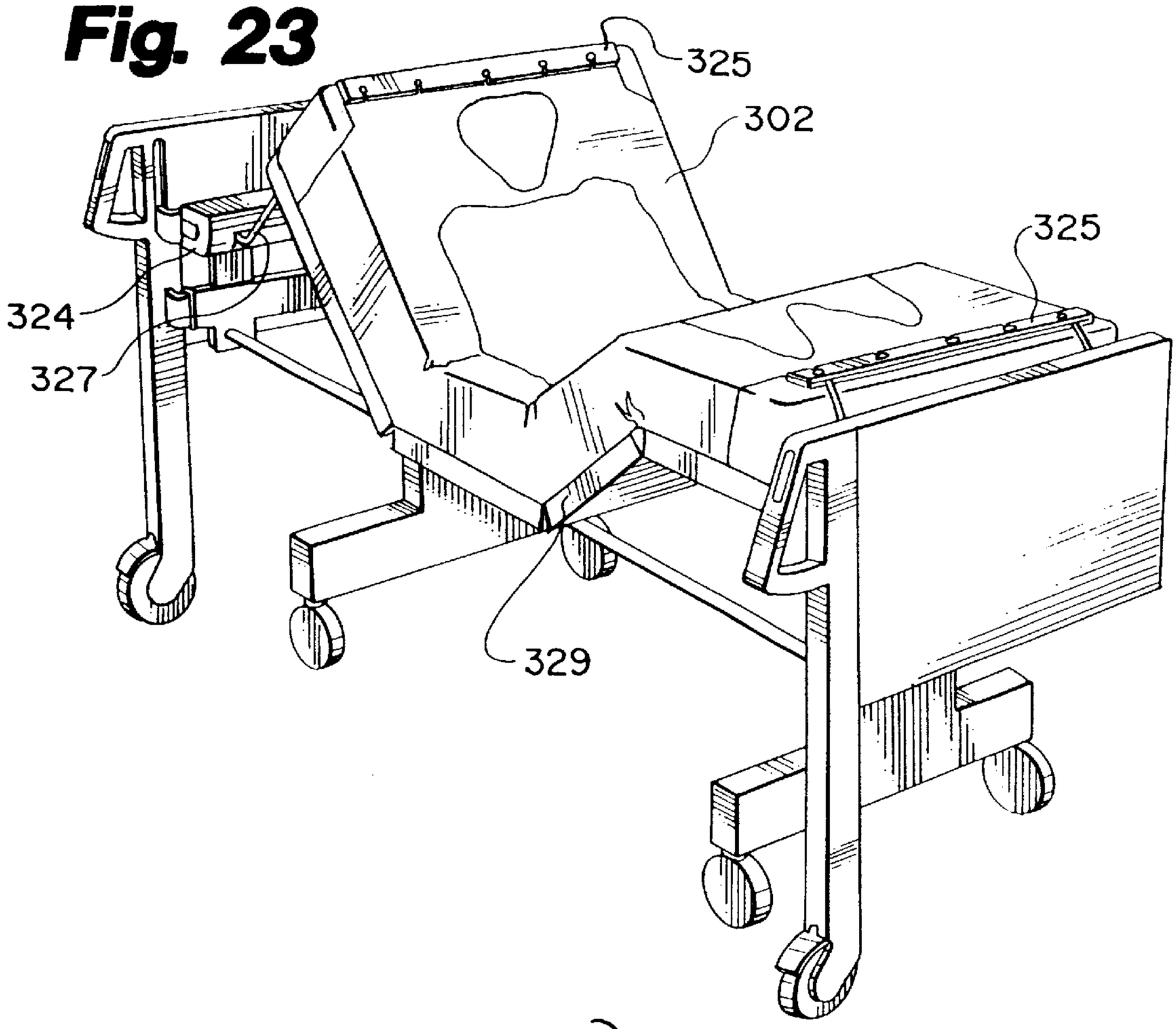

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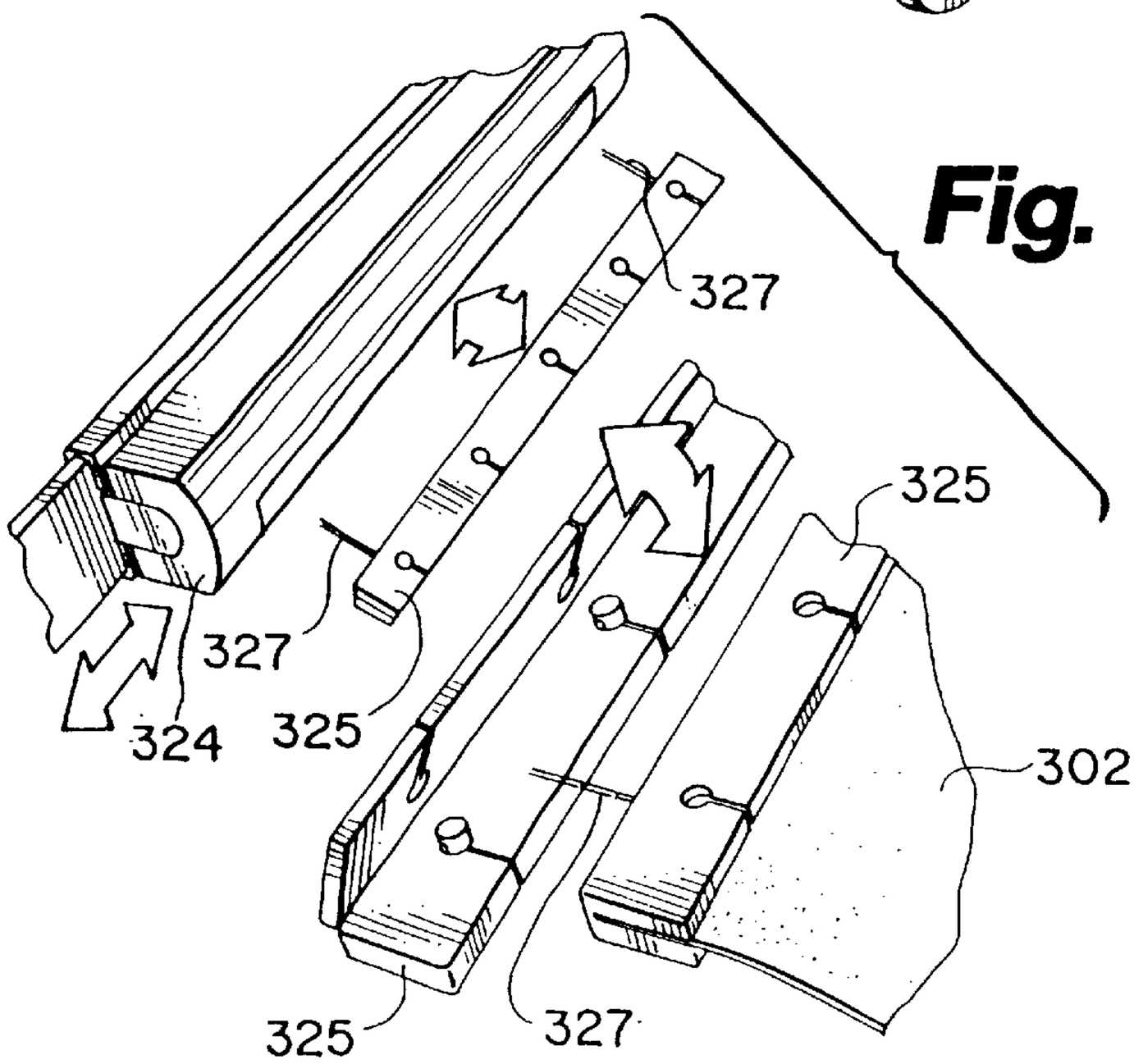

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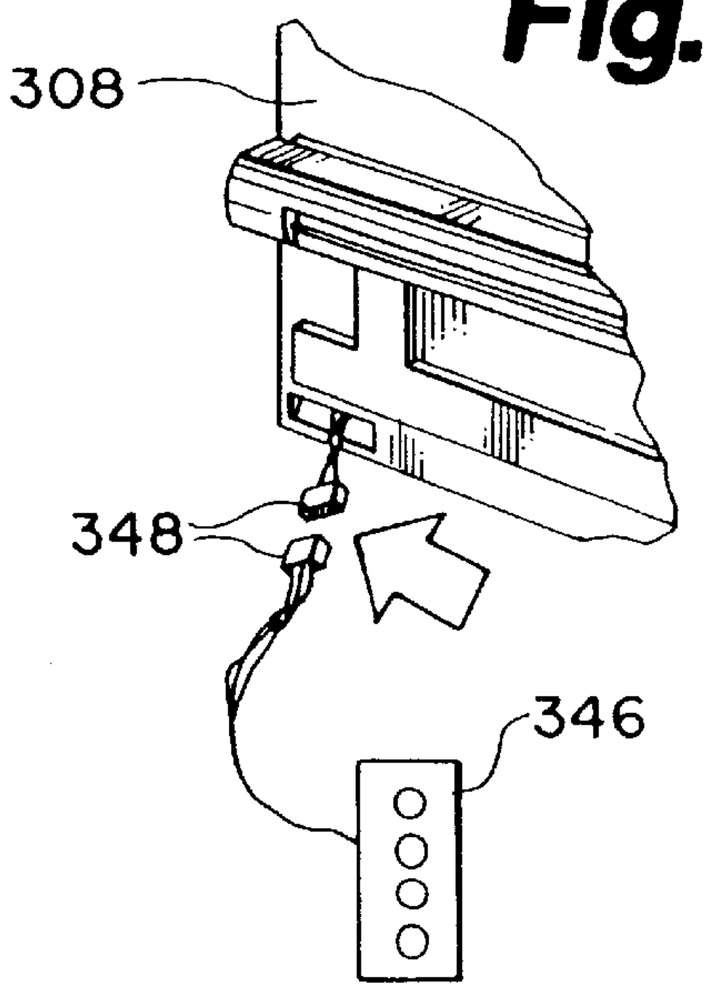

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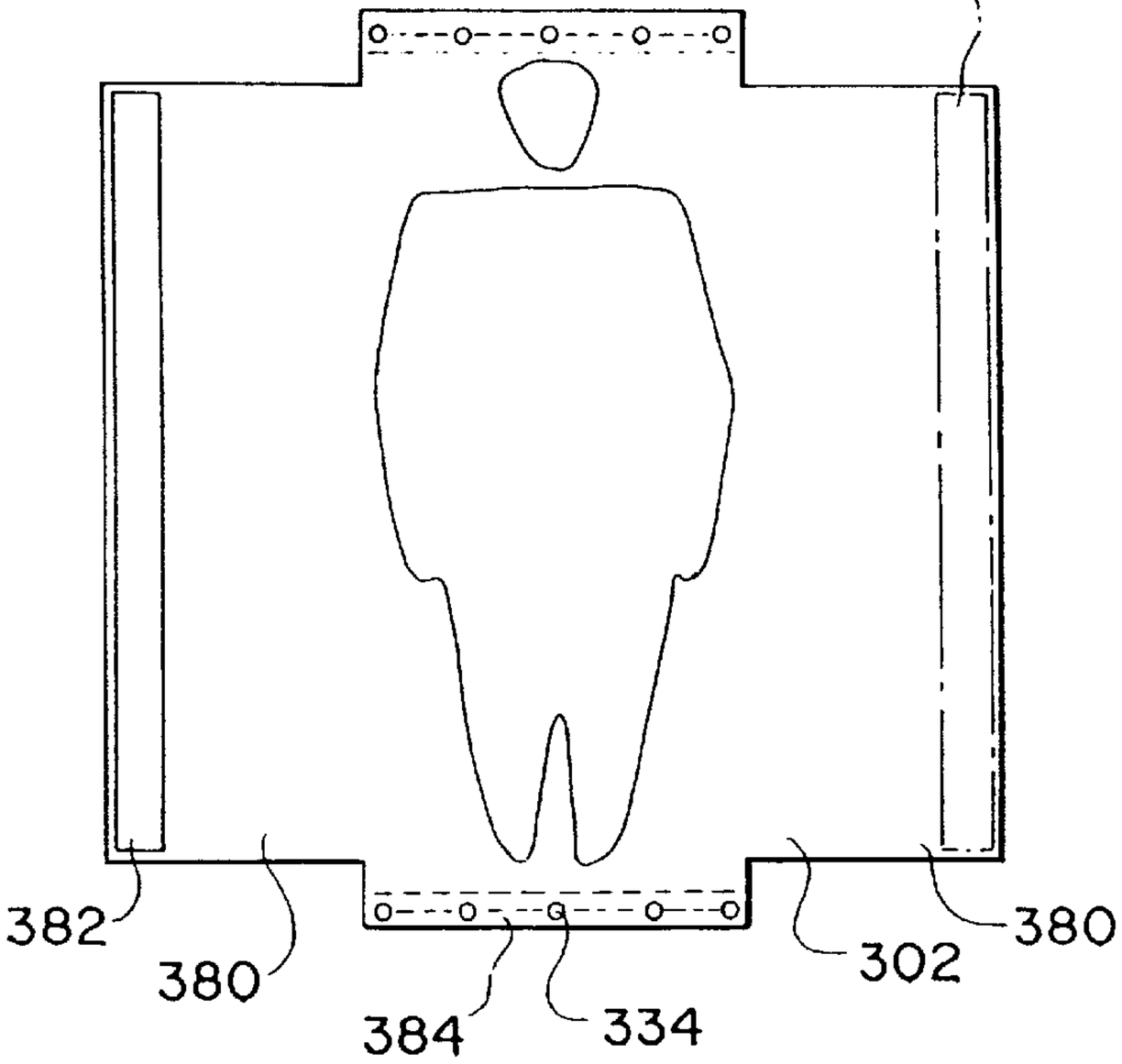

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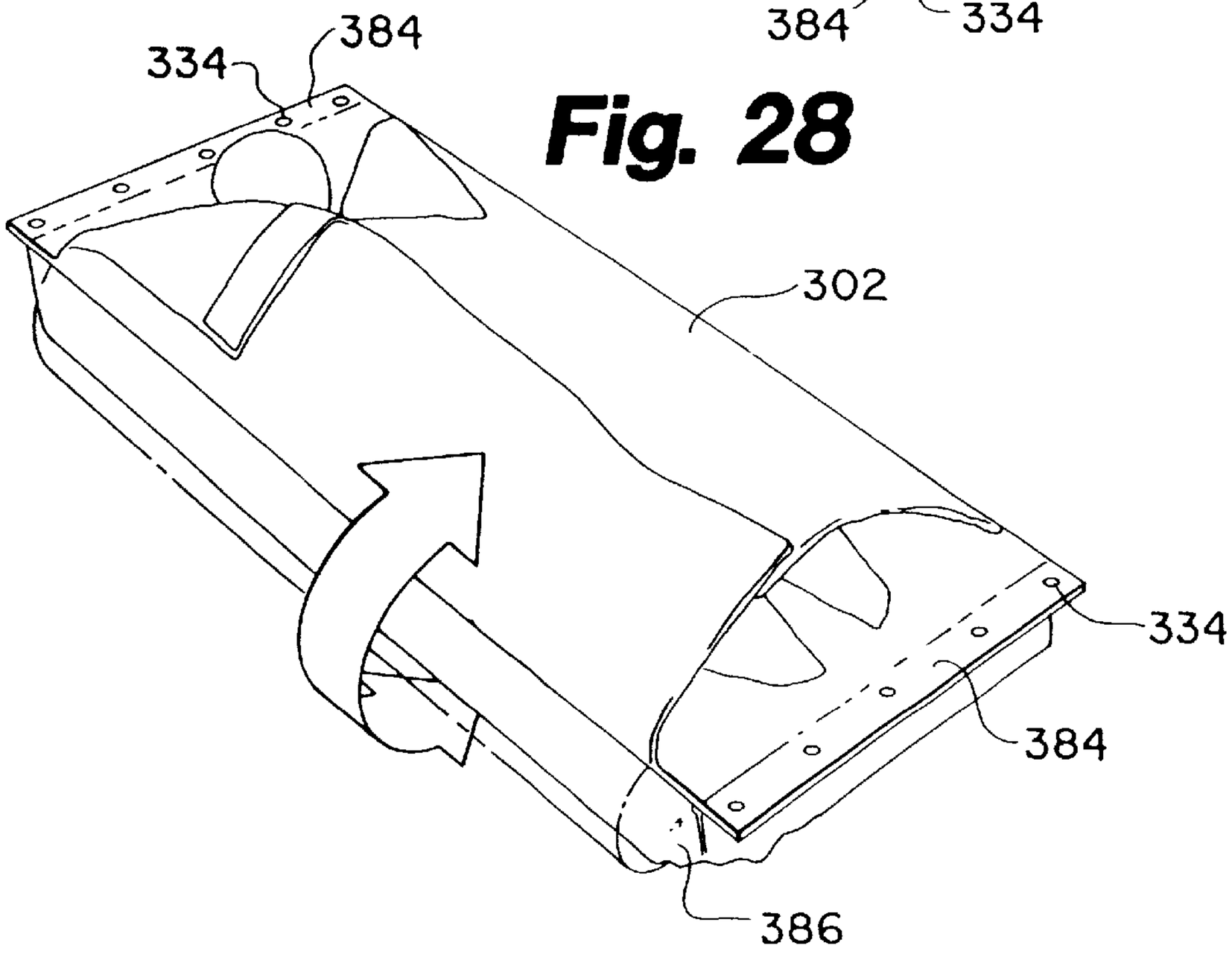

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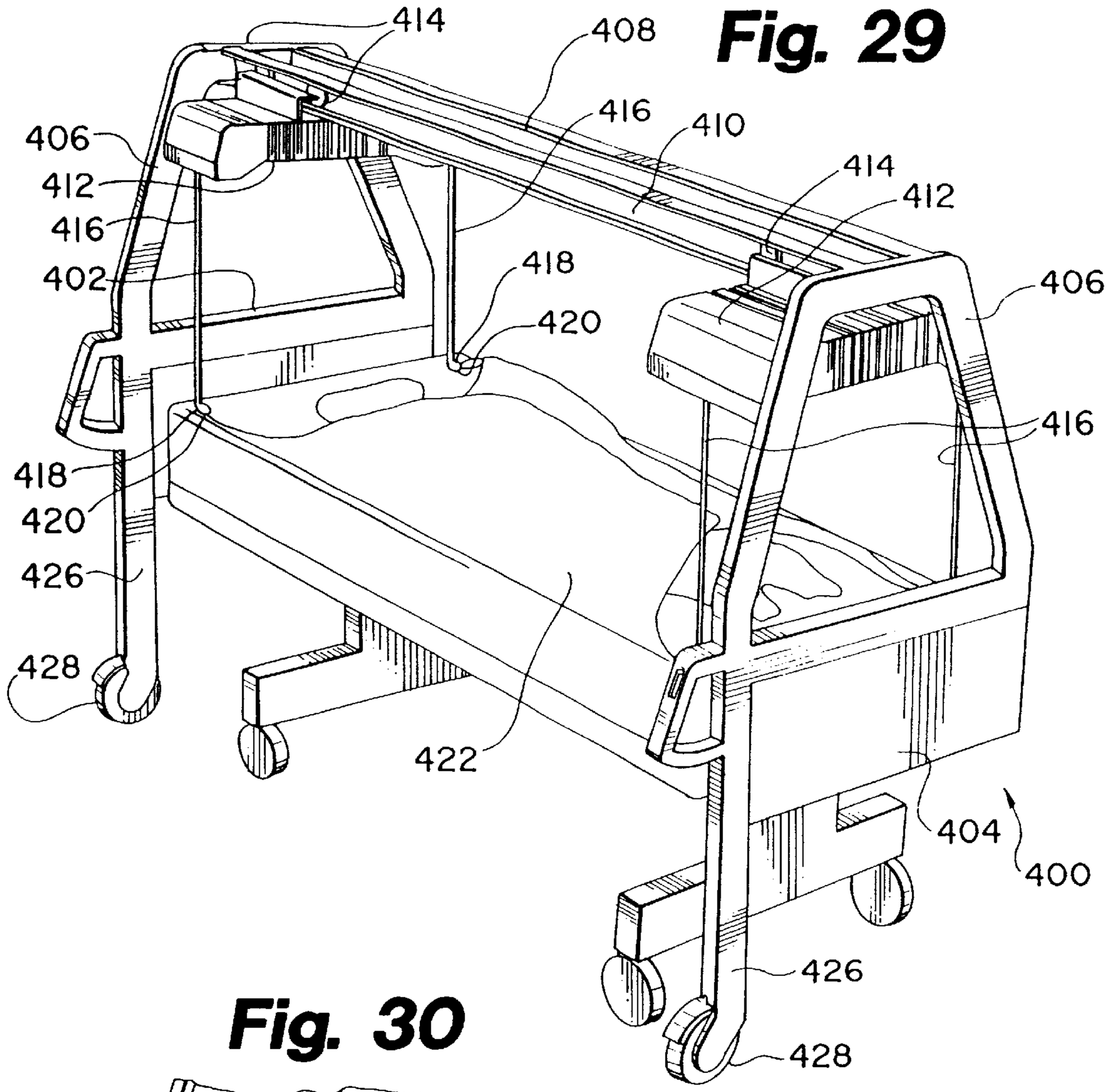
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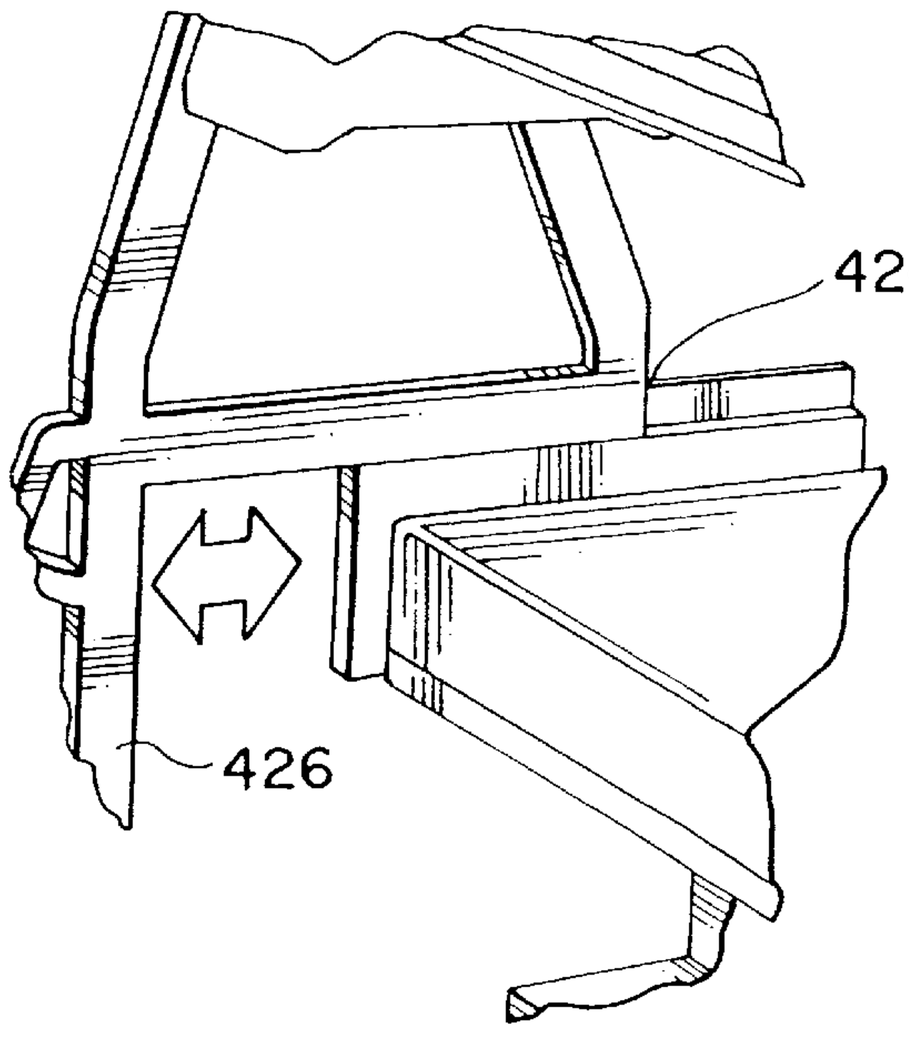
Fig. 30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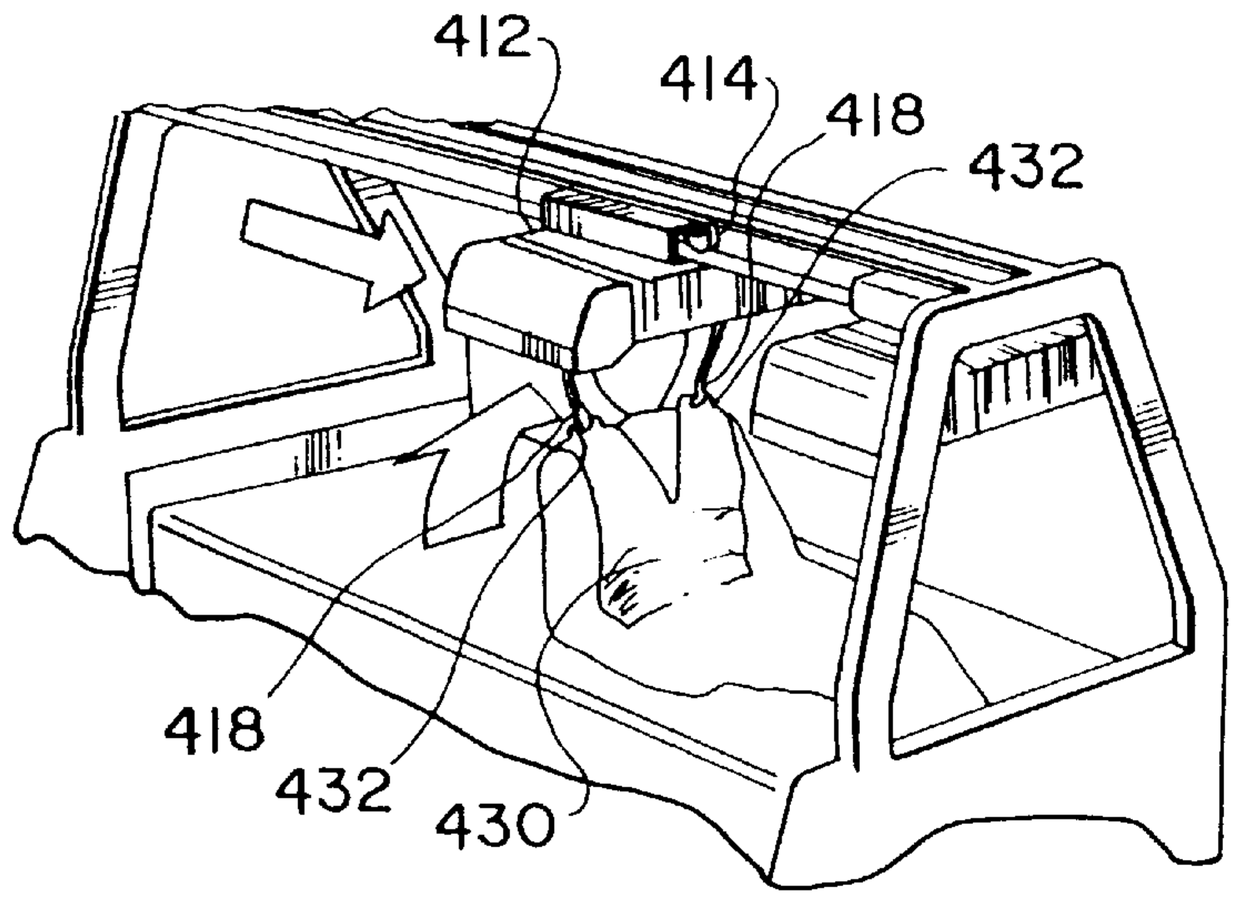
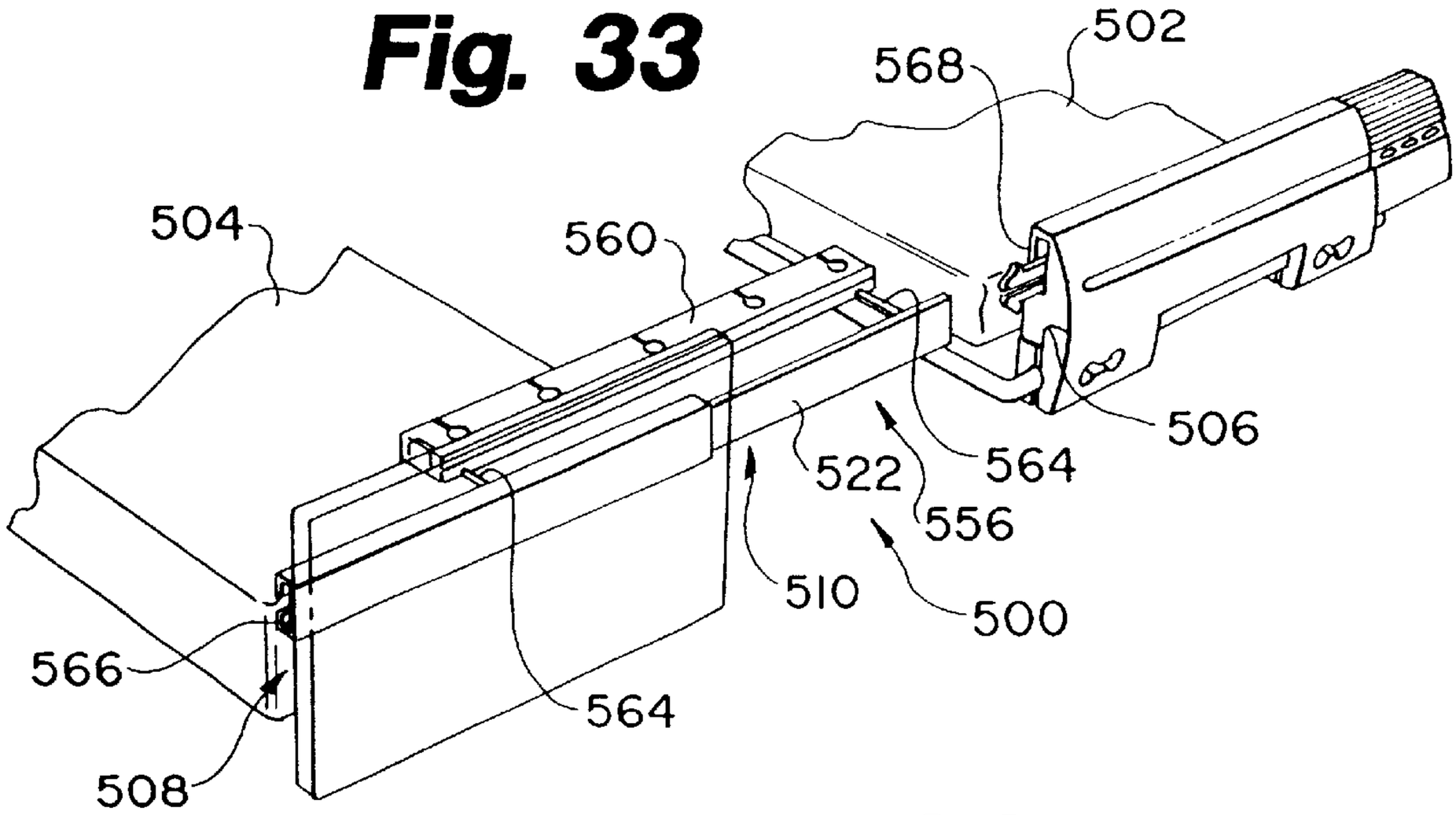


Fig. 32

Fig. 33



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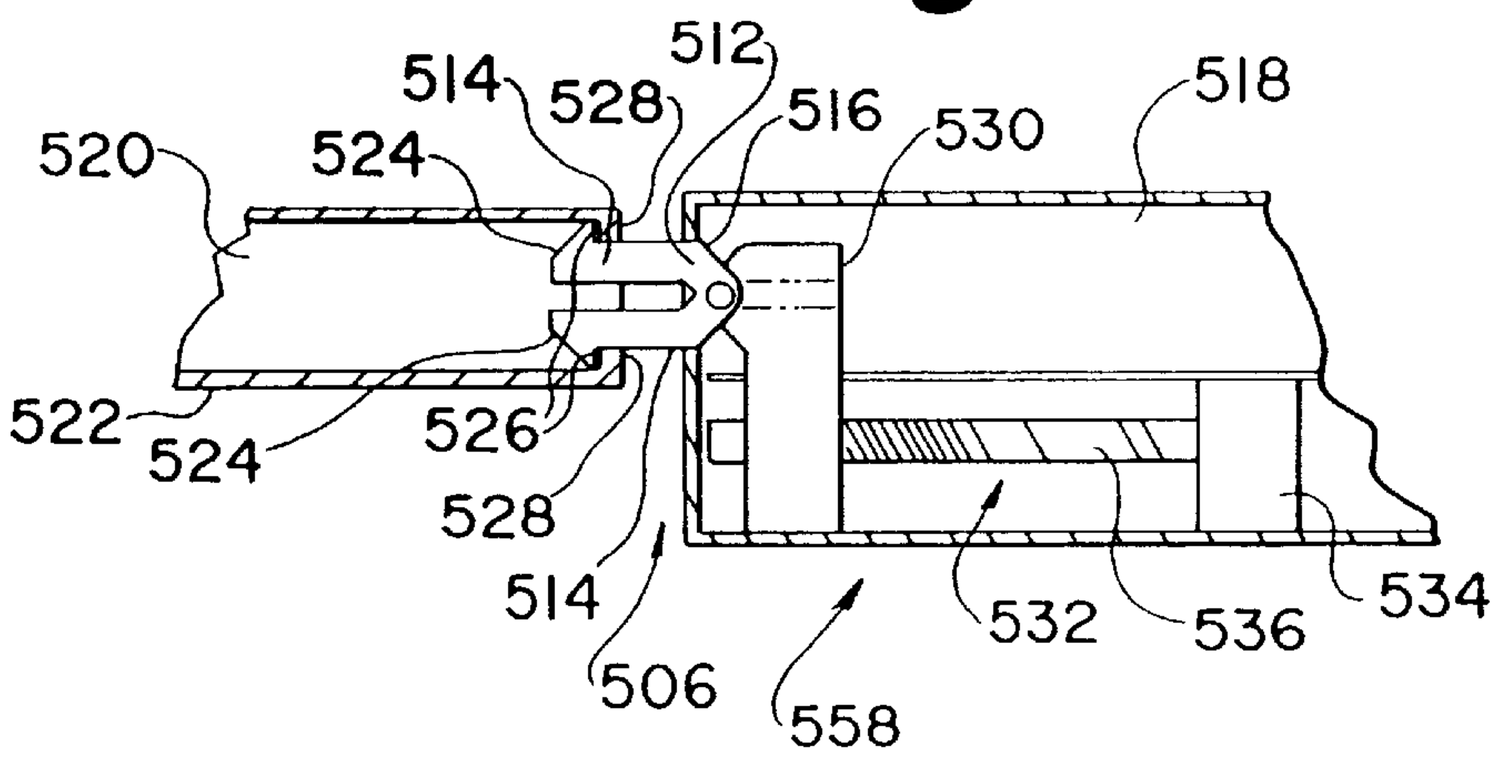

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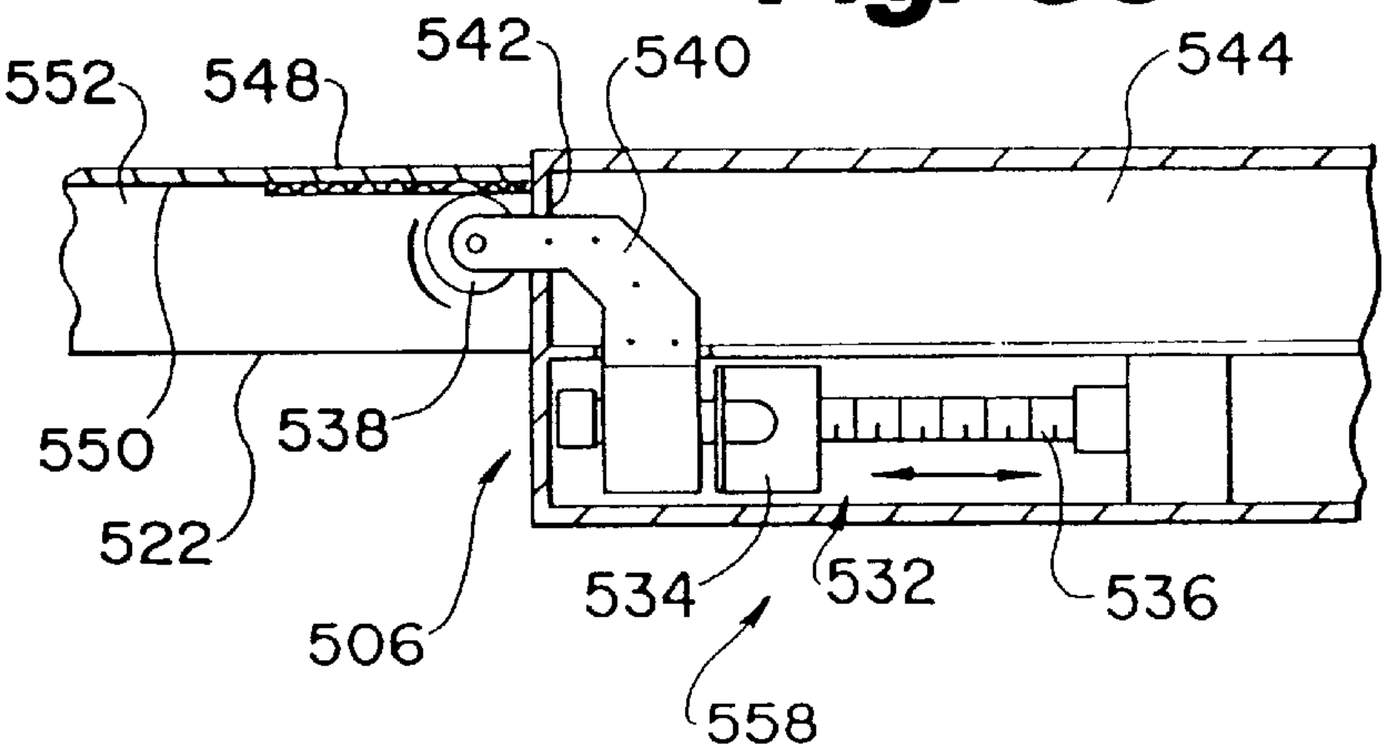

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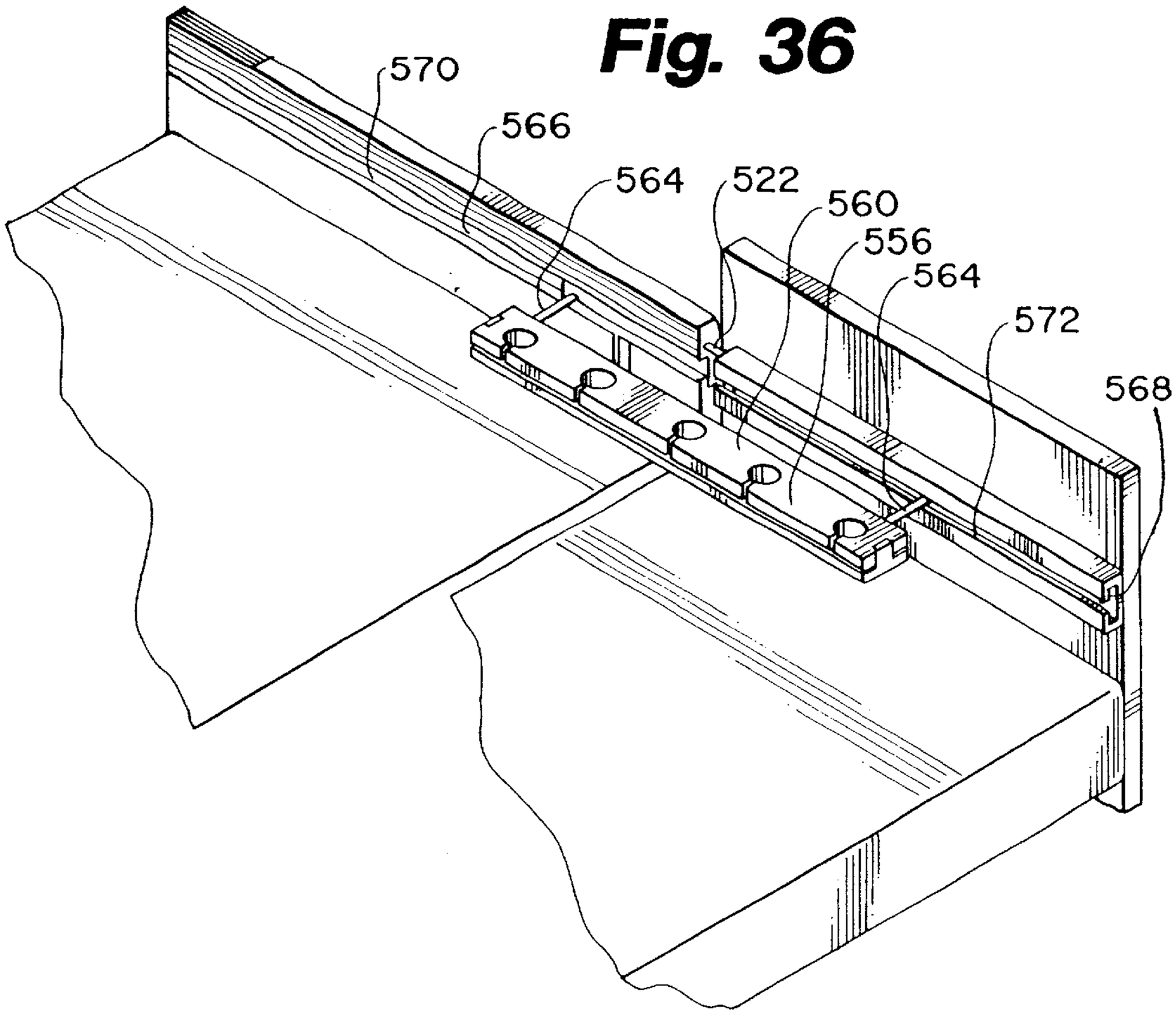
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Fig. 37

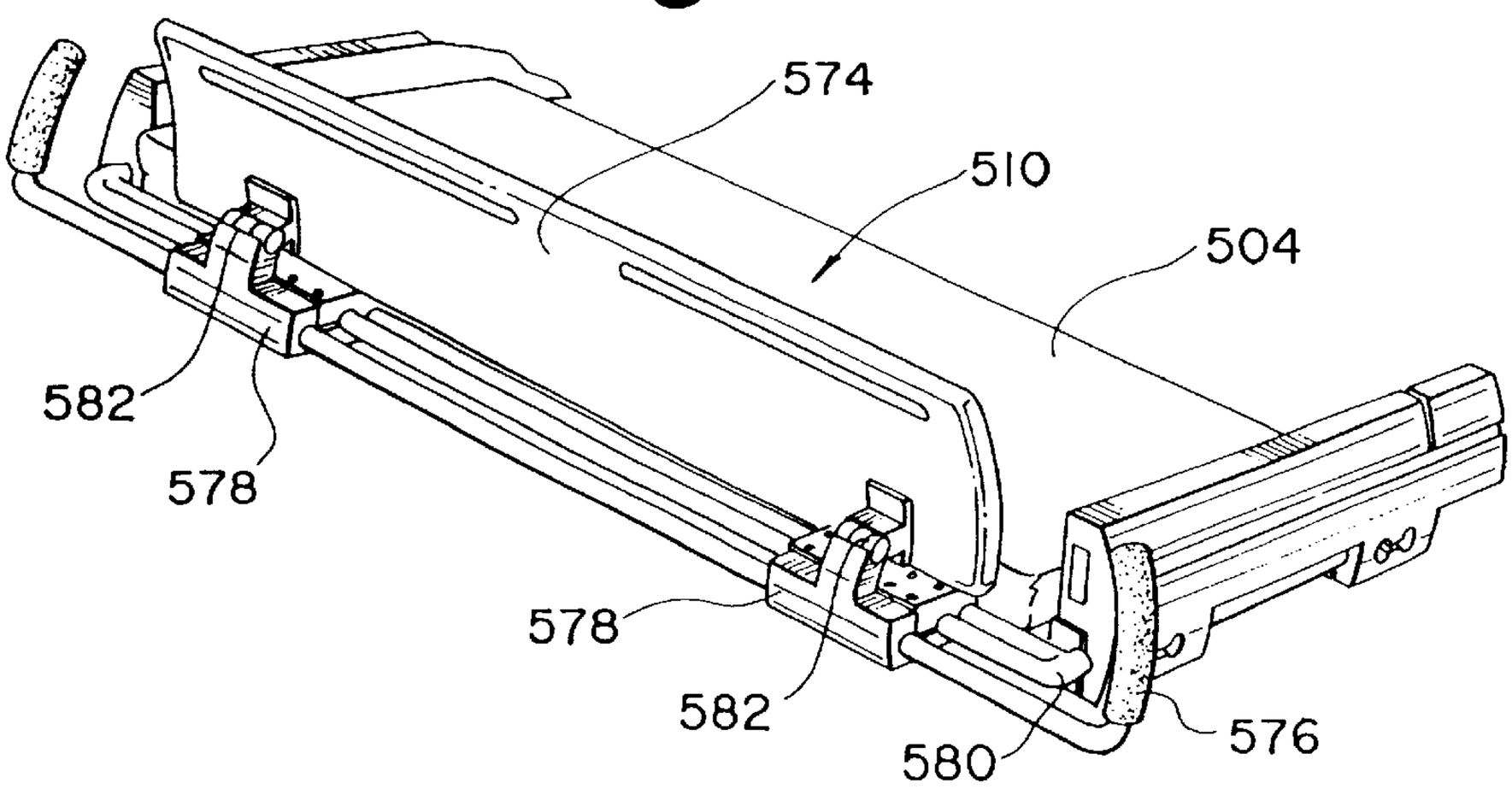
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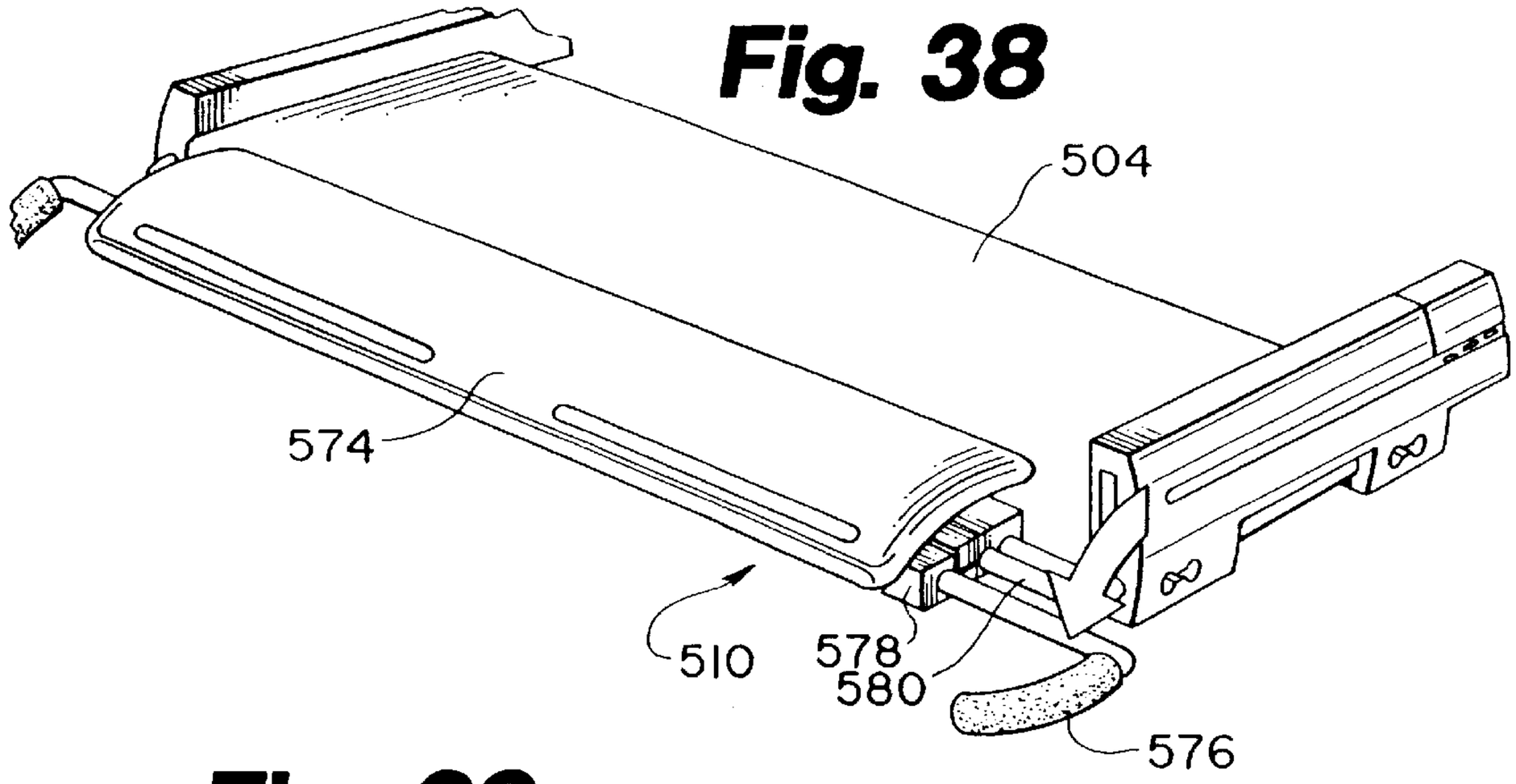
Fig. 38



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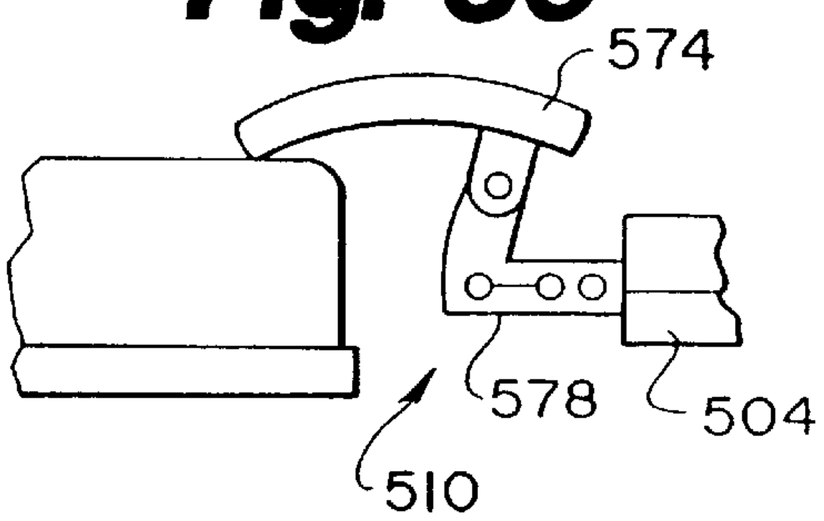

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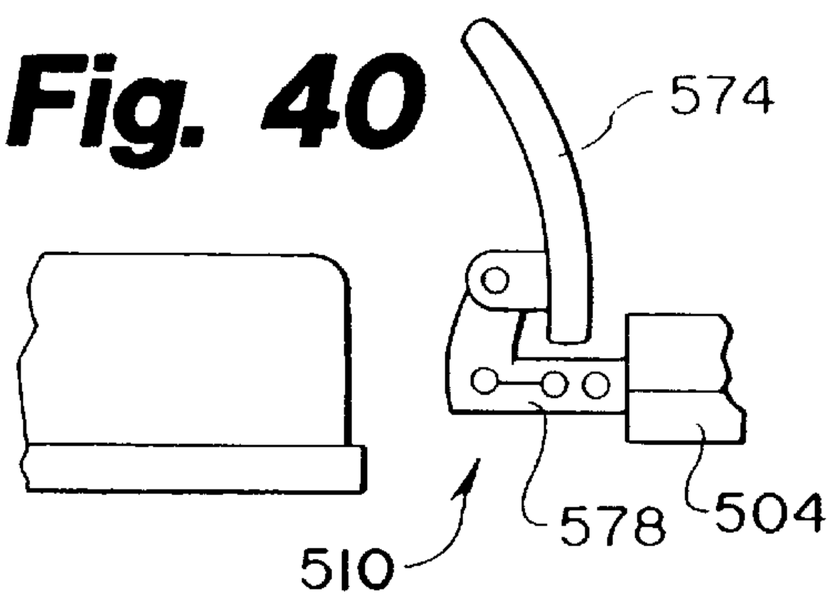

Fig. 41

Fig. 42

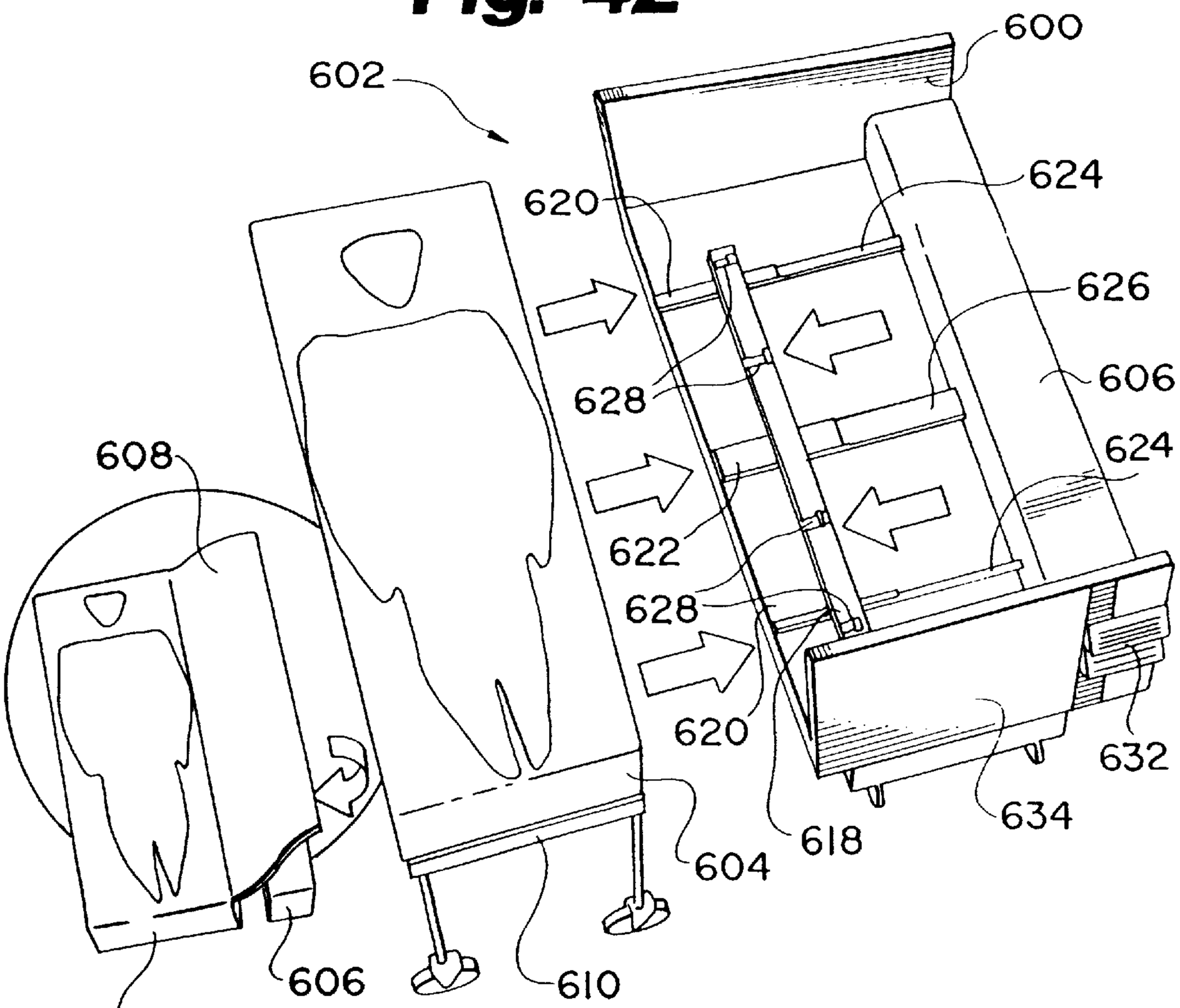
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Fig. 43

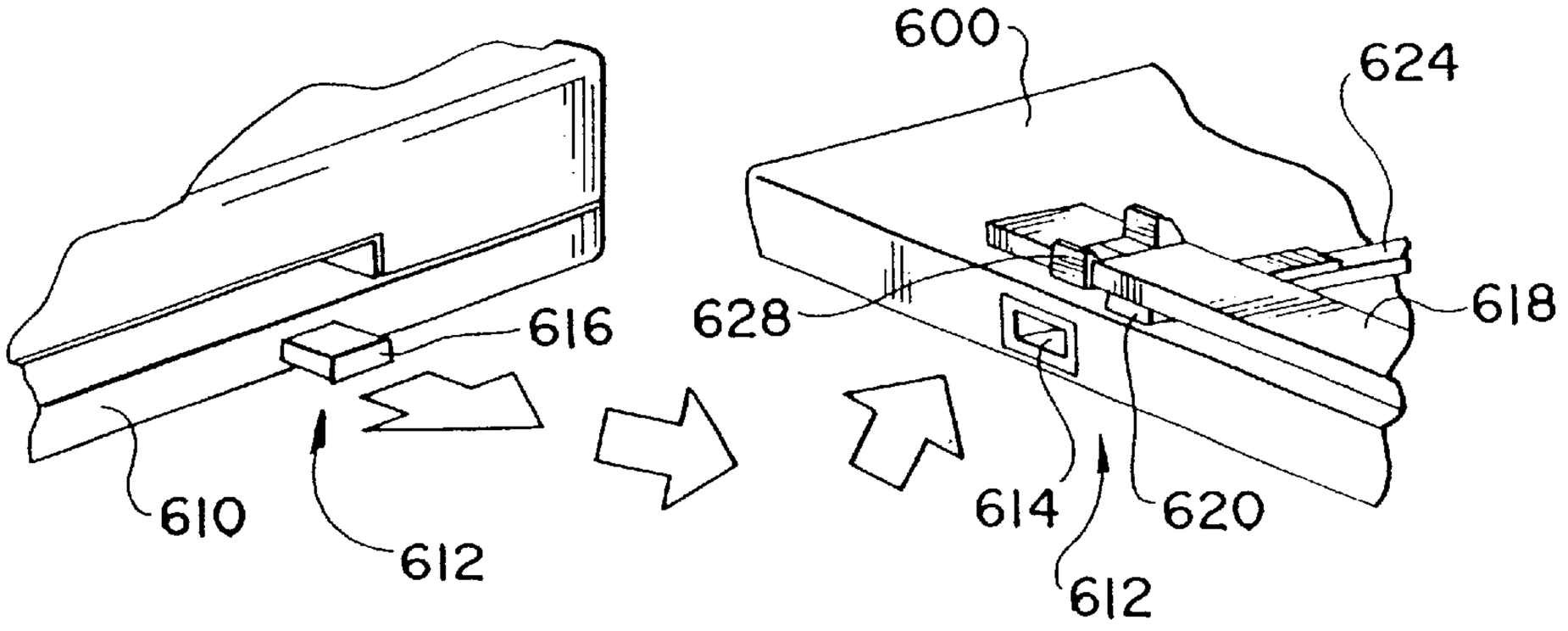
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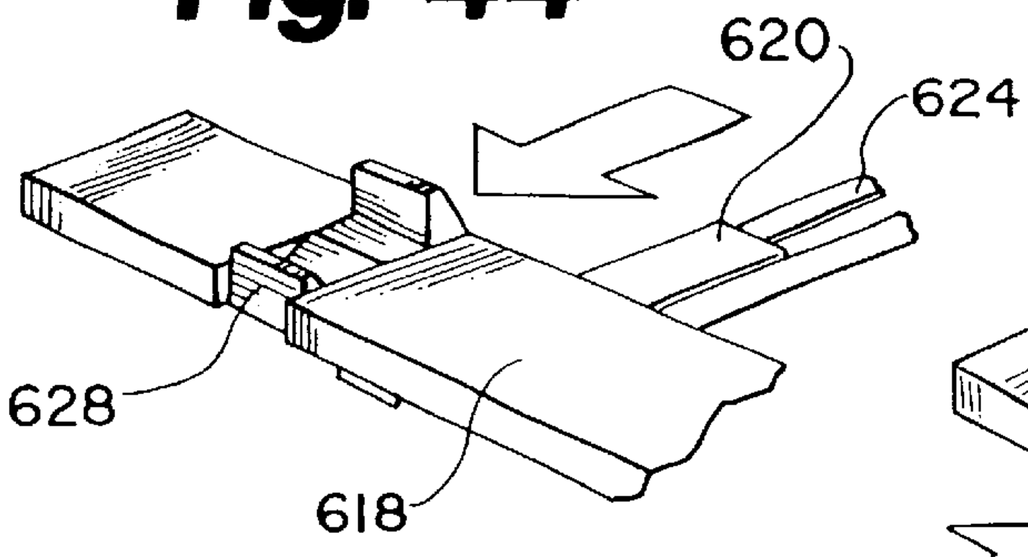
Fig. 44



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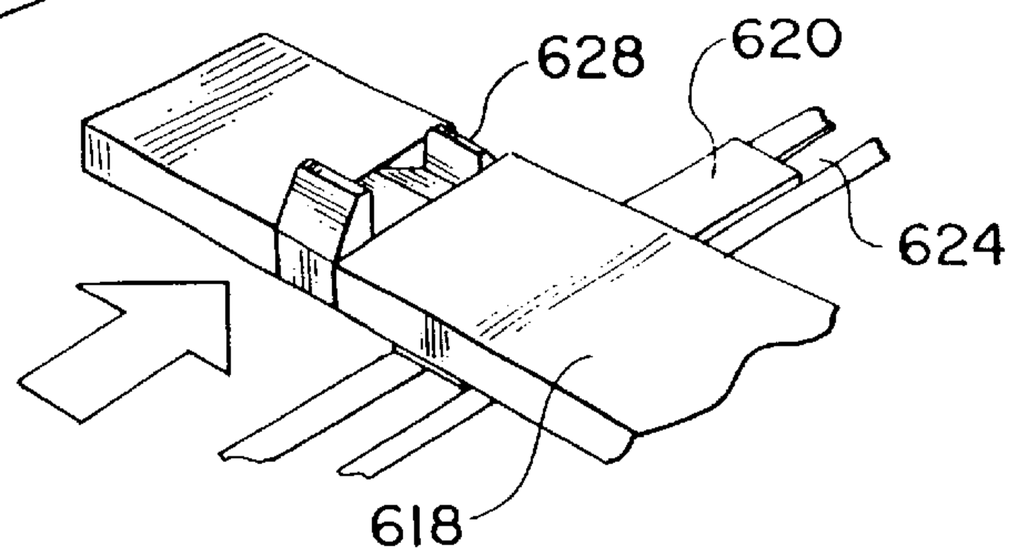

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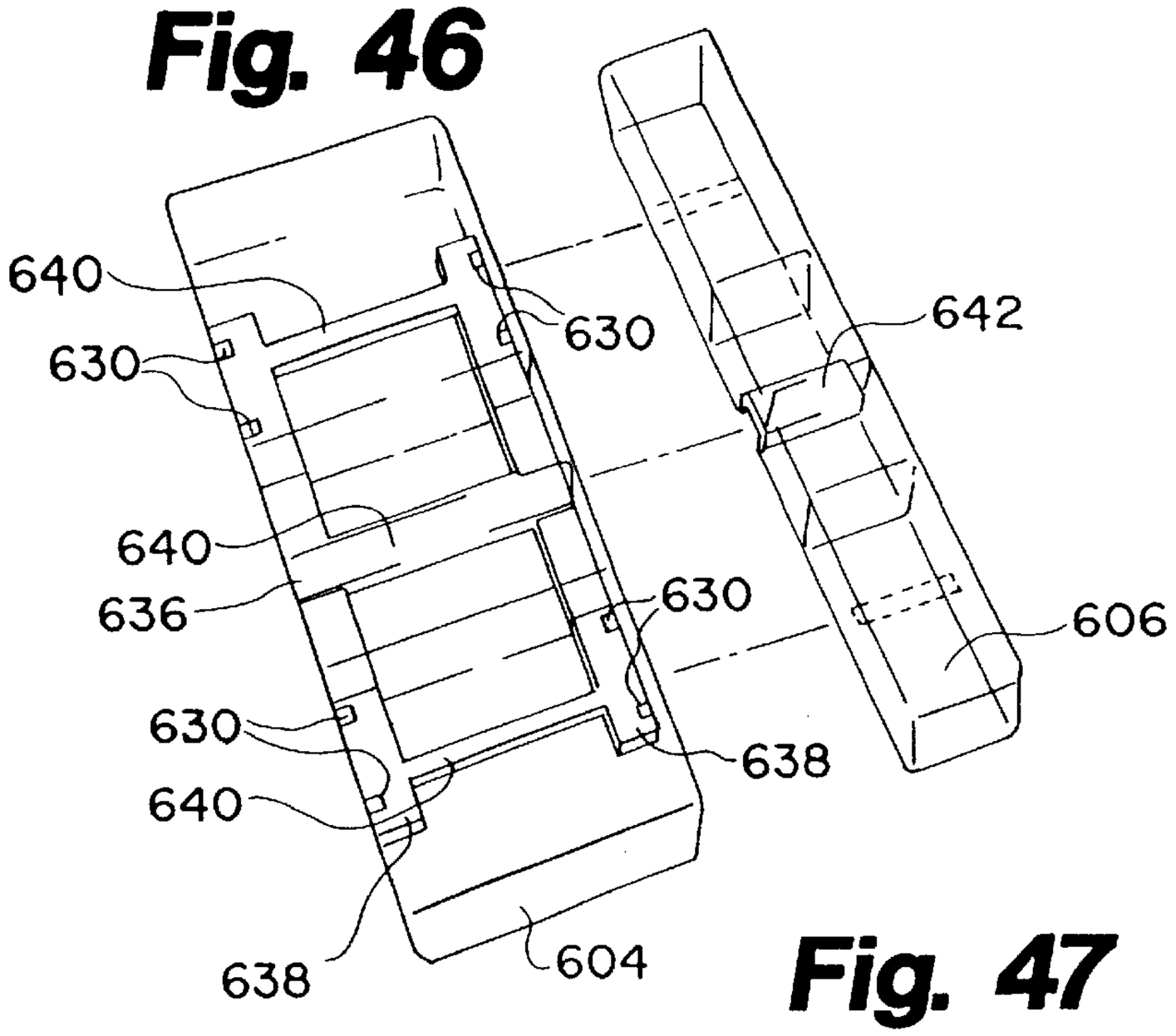

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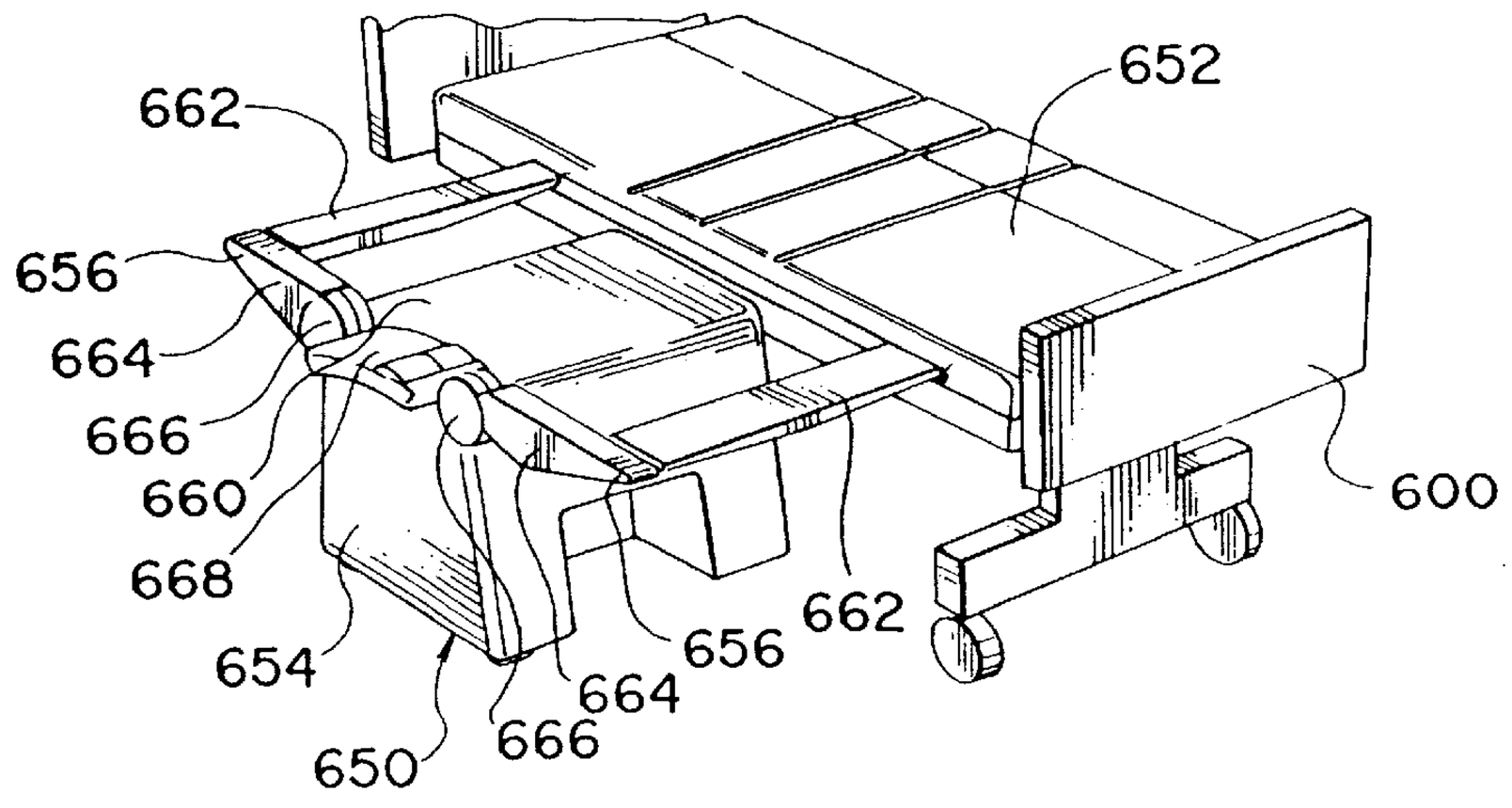


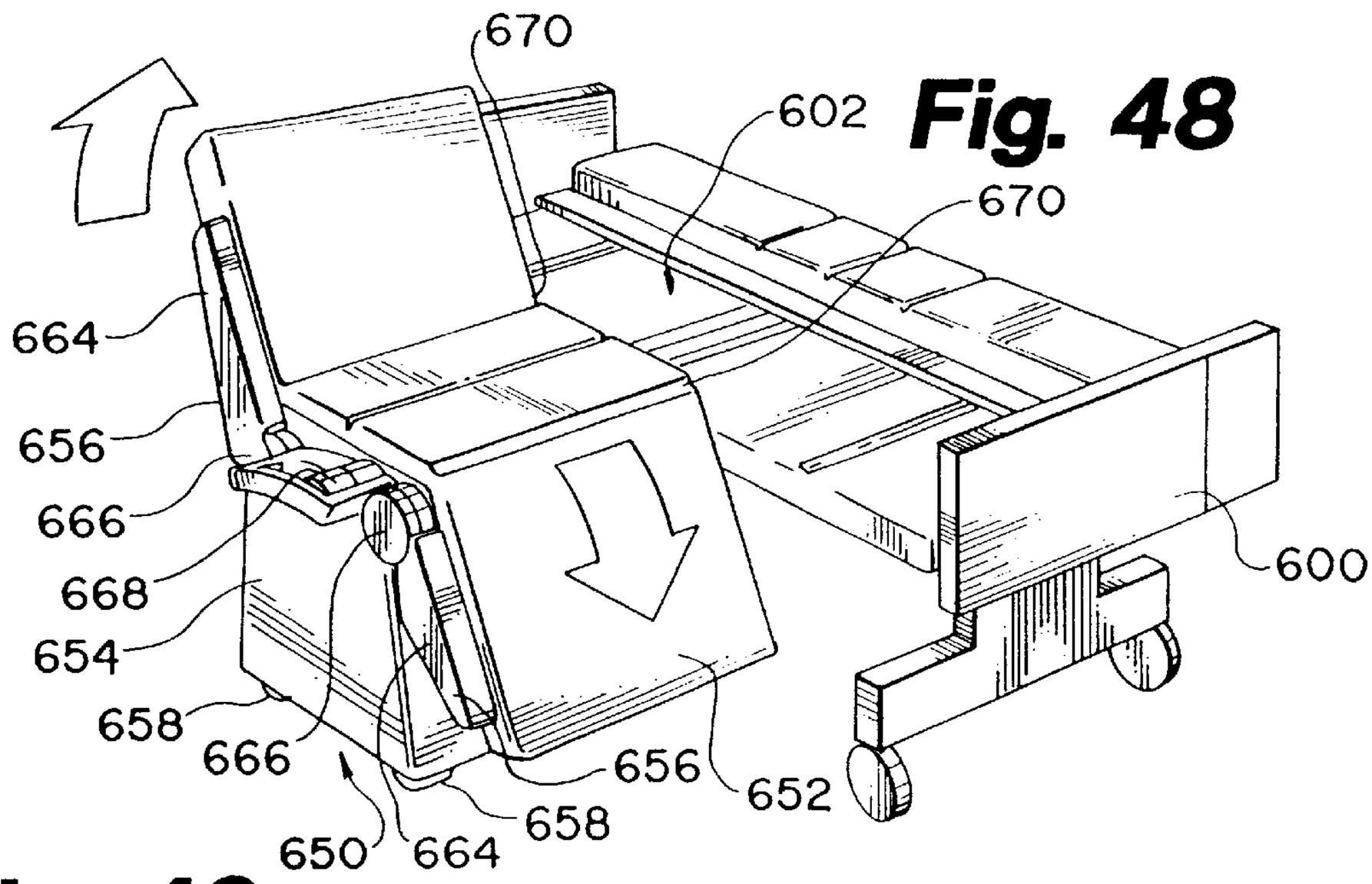
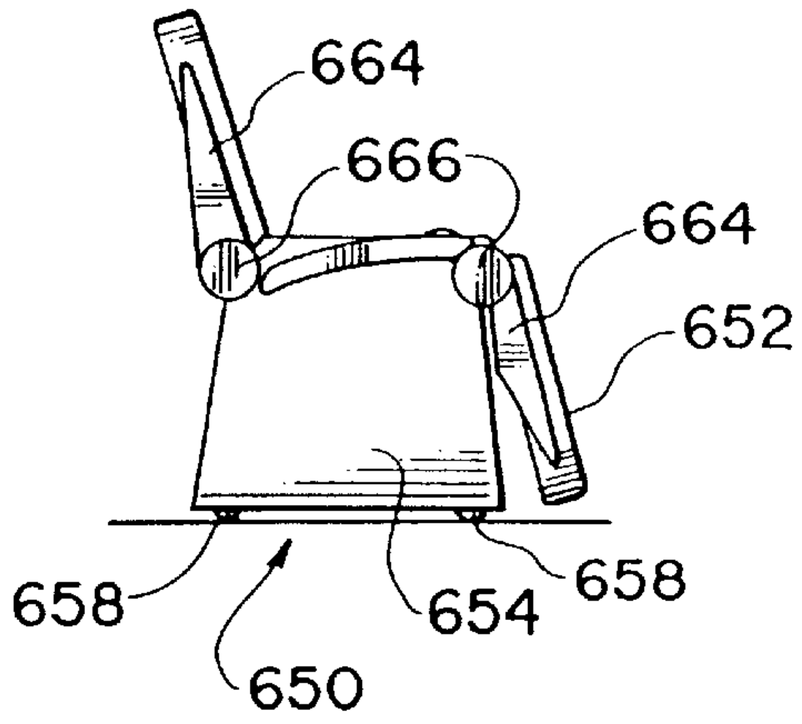


Fig. 48

Fig. 49



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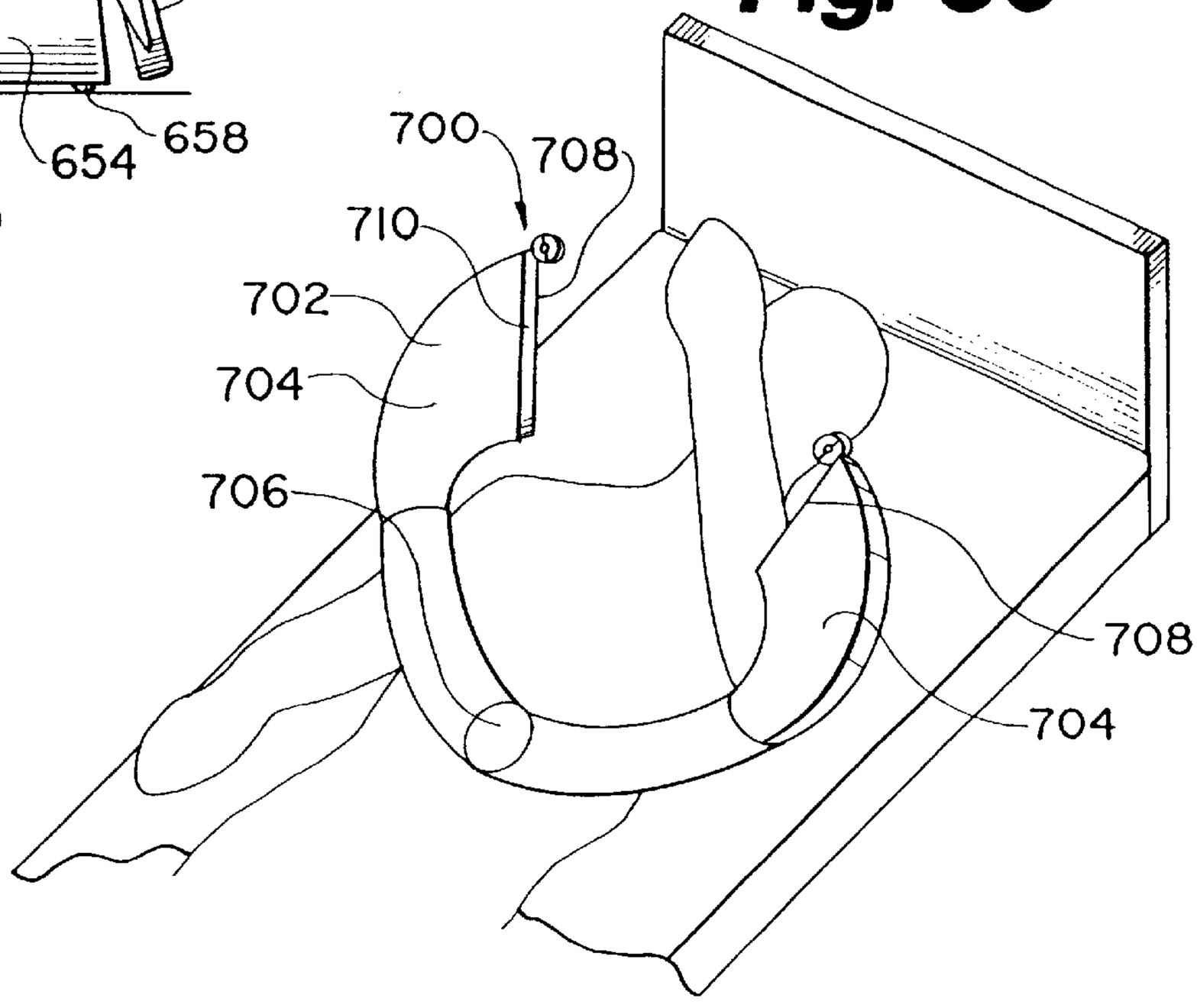

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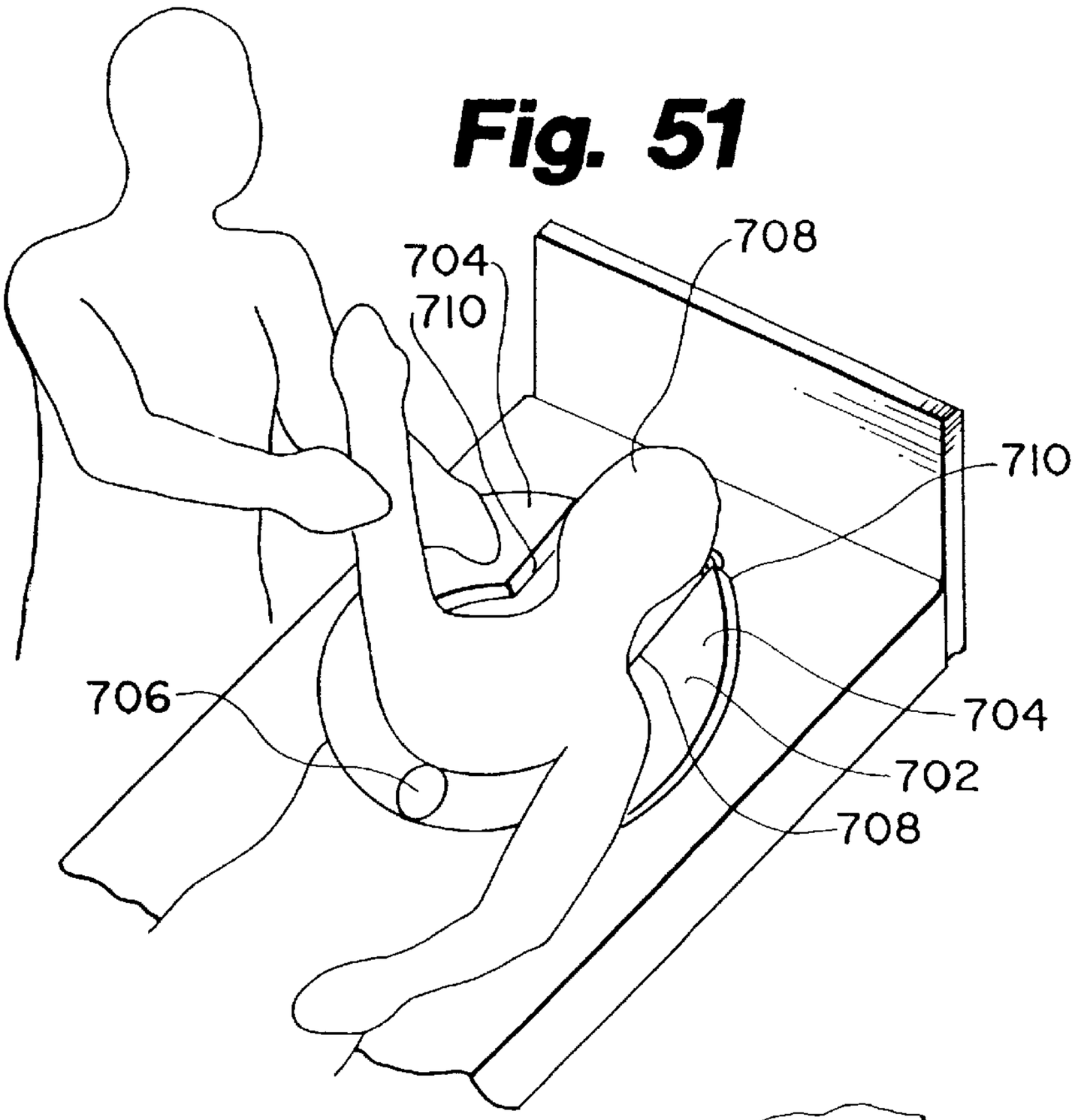
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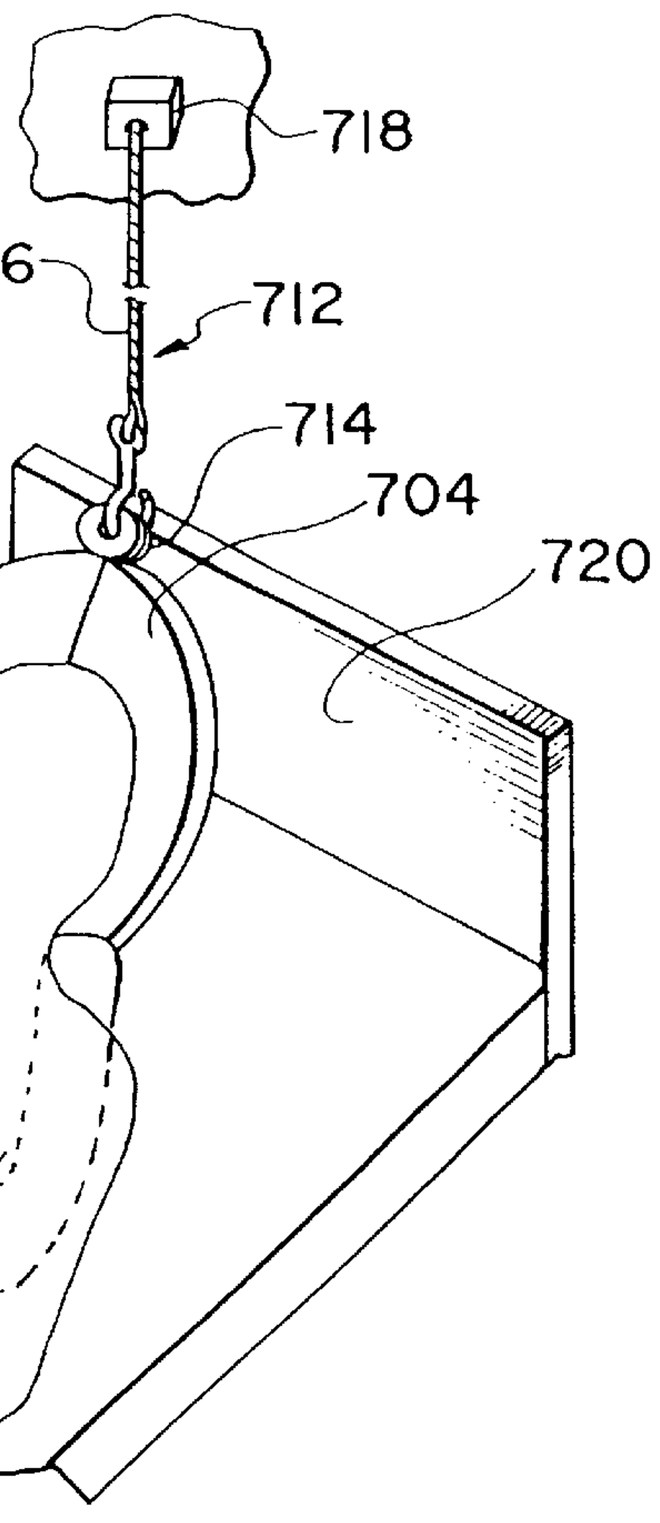
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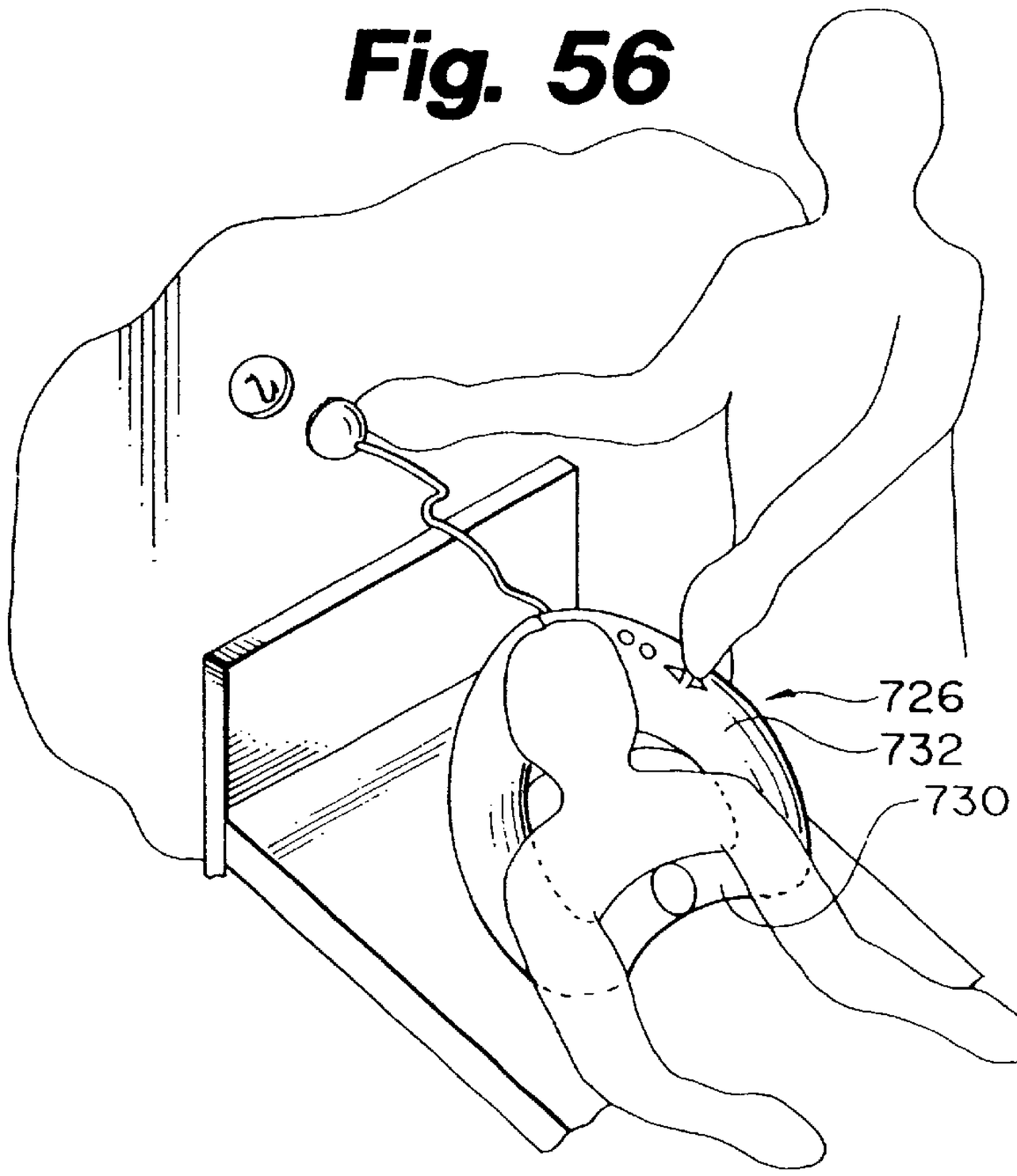
Fig. 52

Fig. 56



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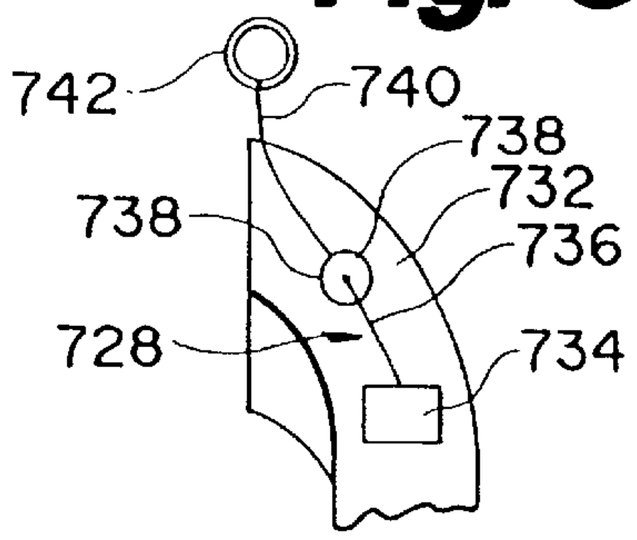

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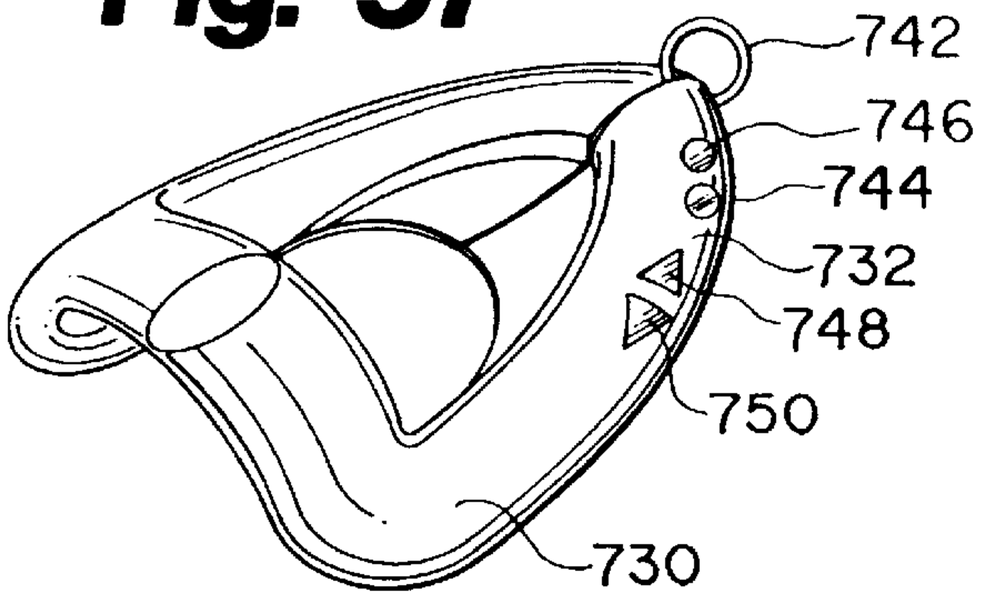

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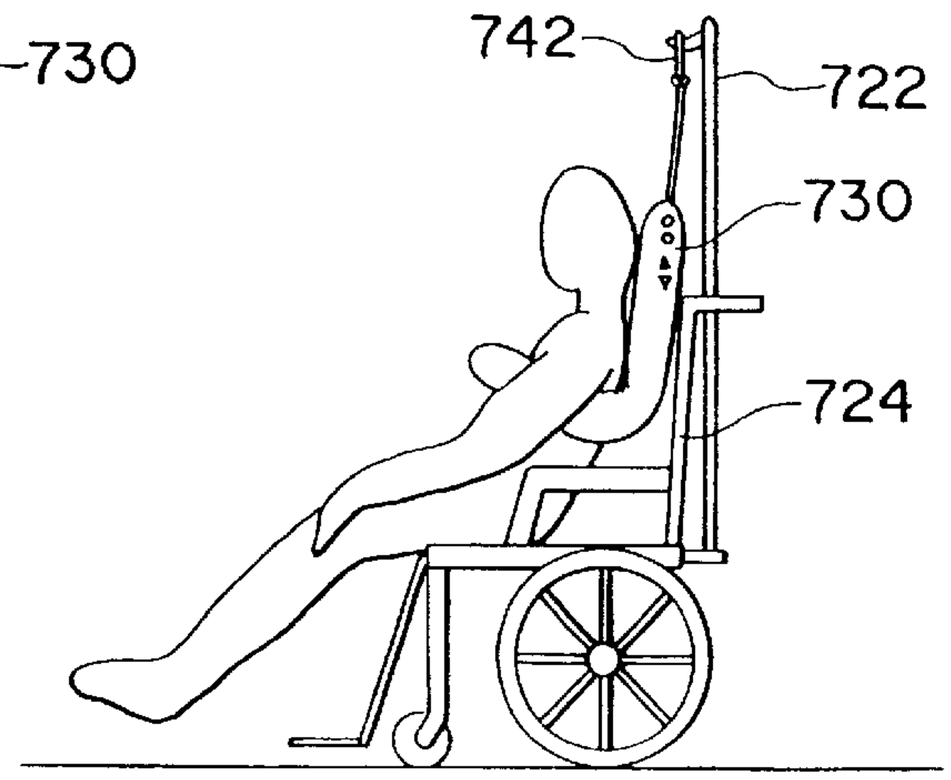

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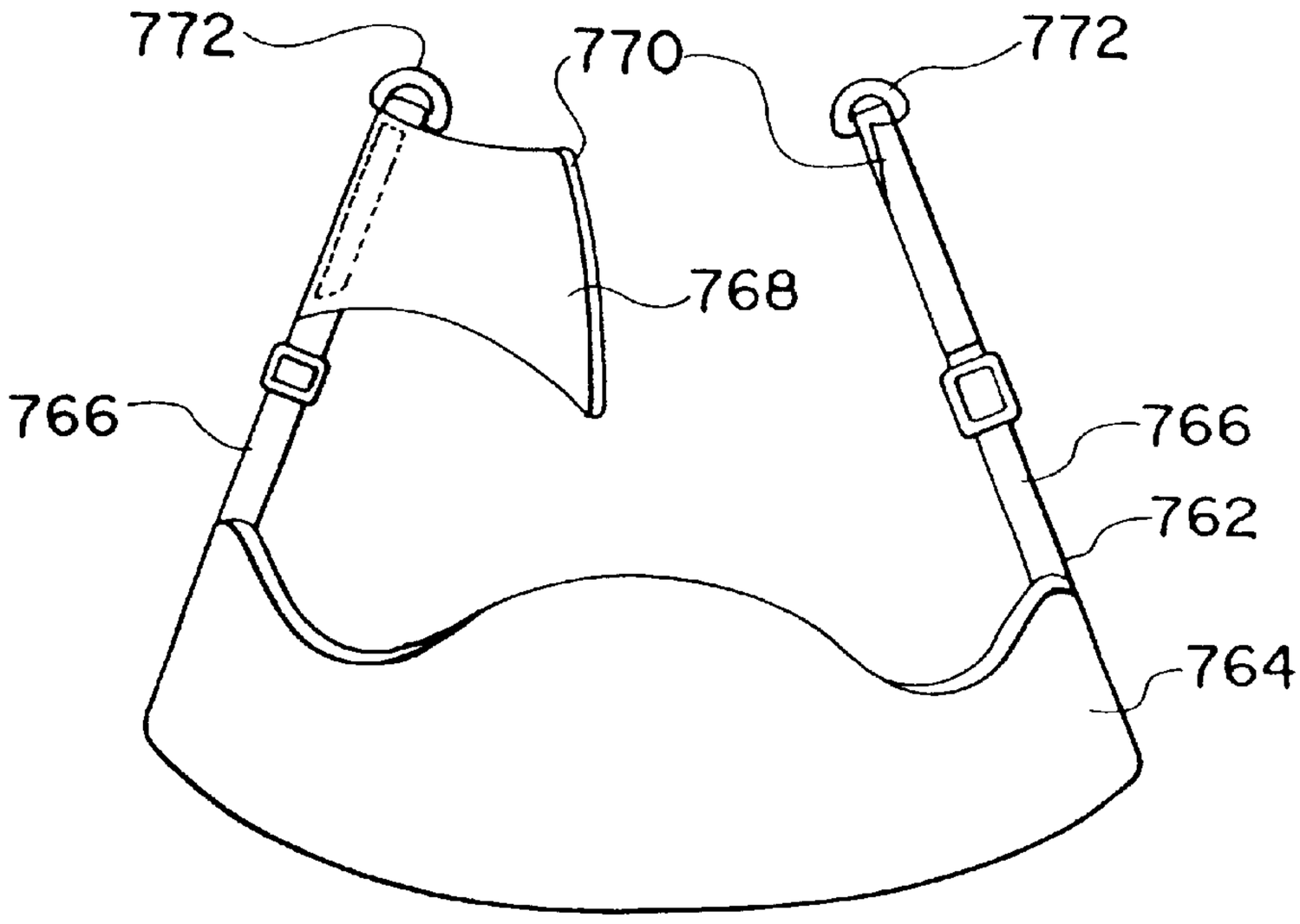

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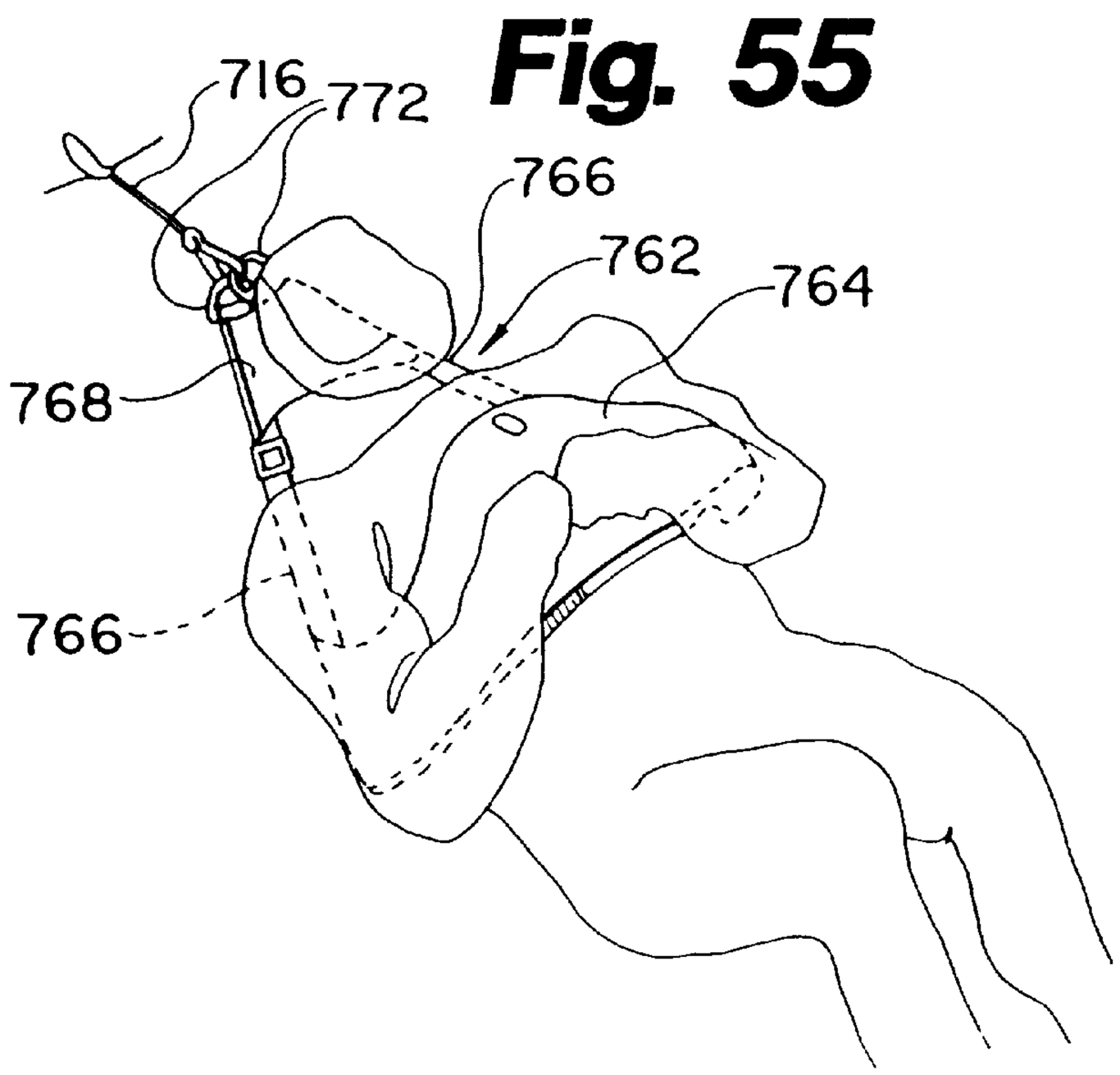

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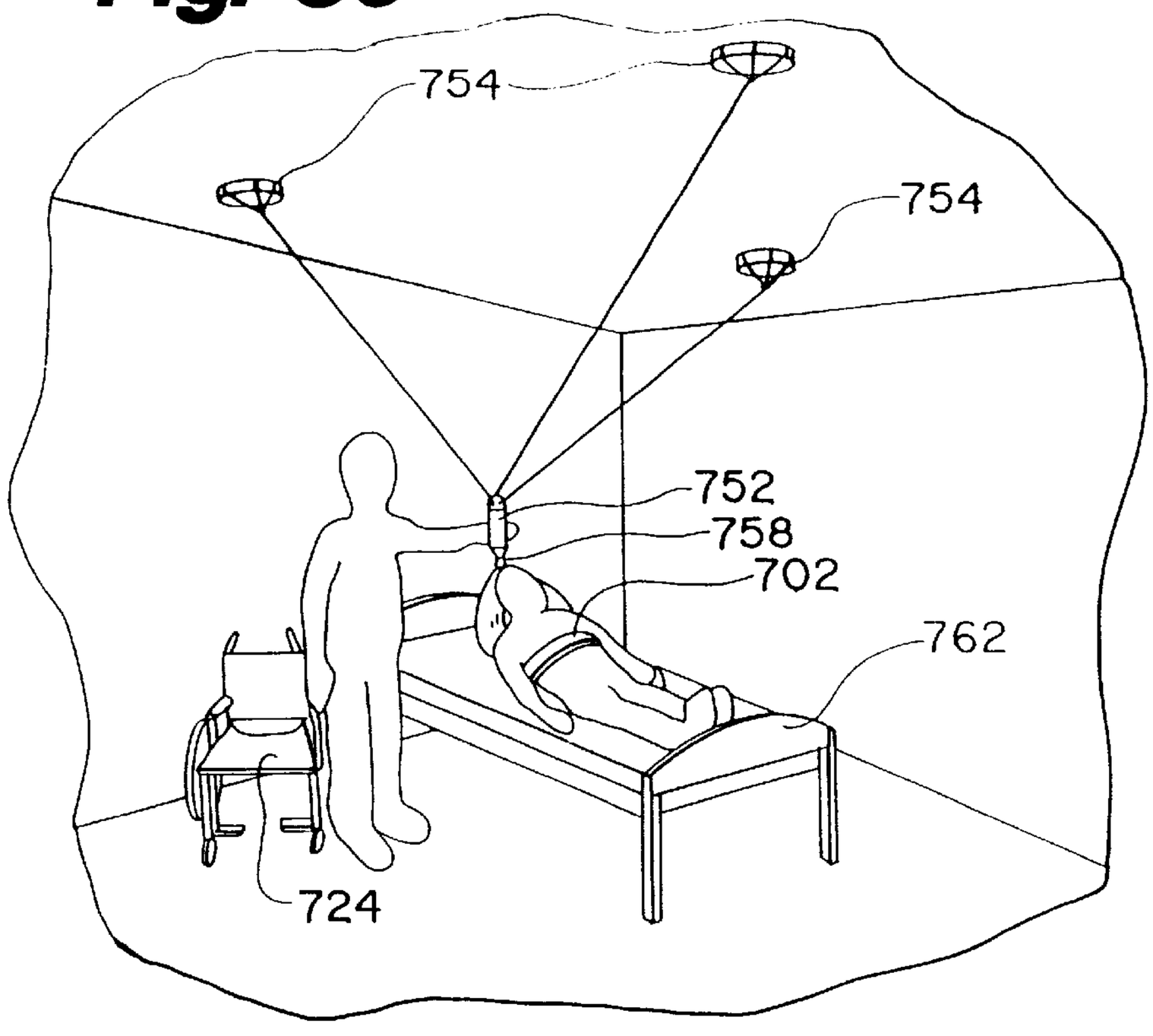

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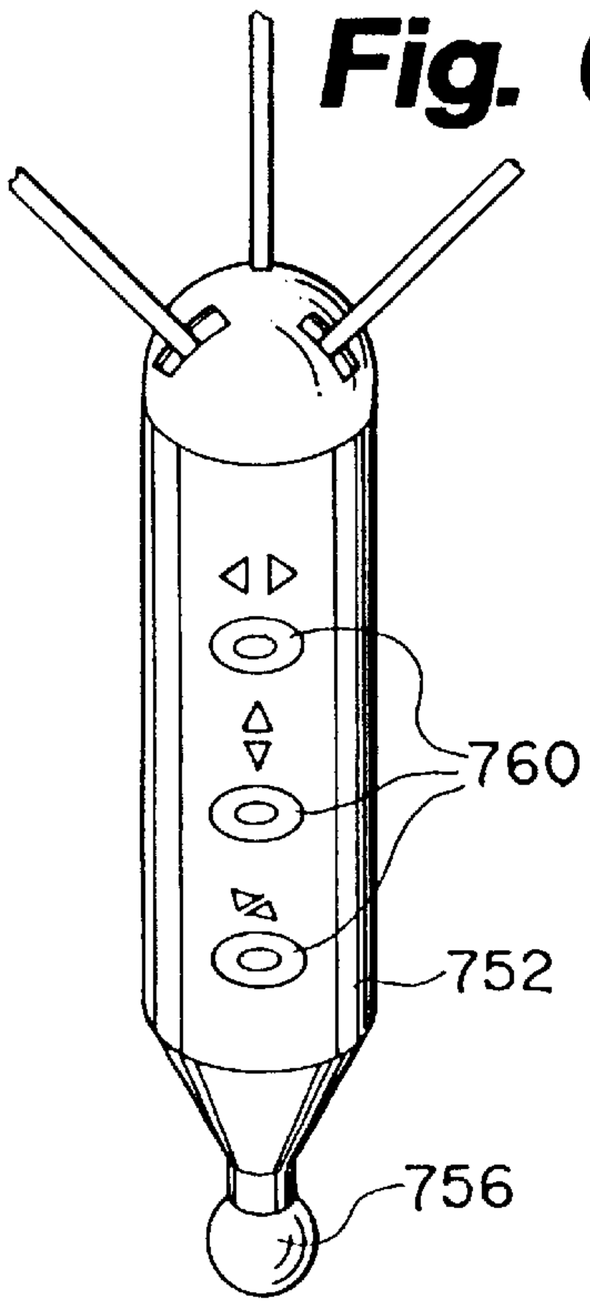

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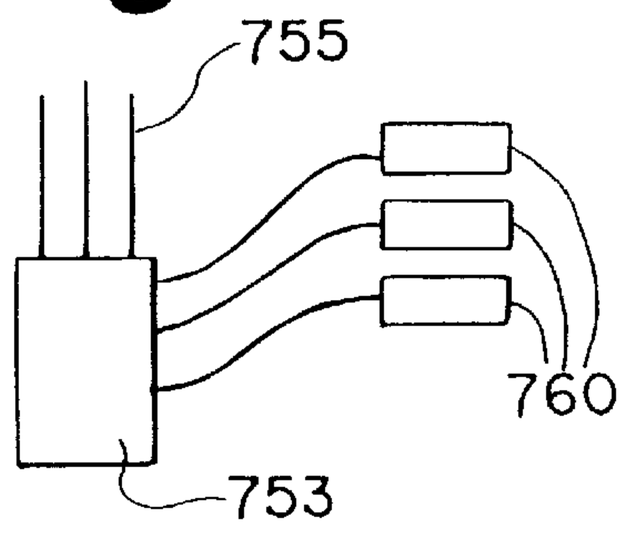

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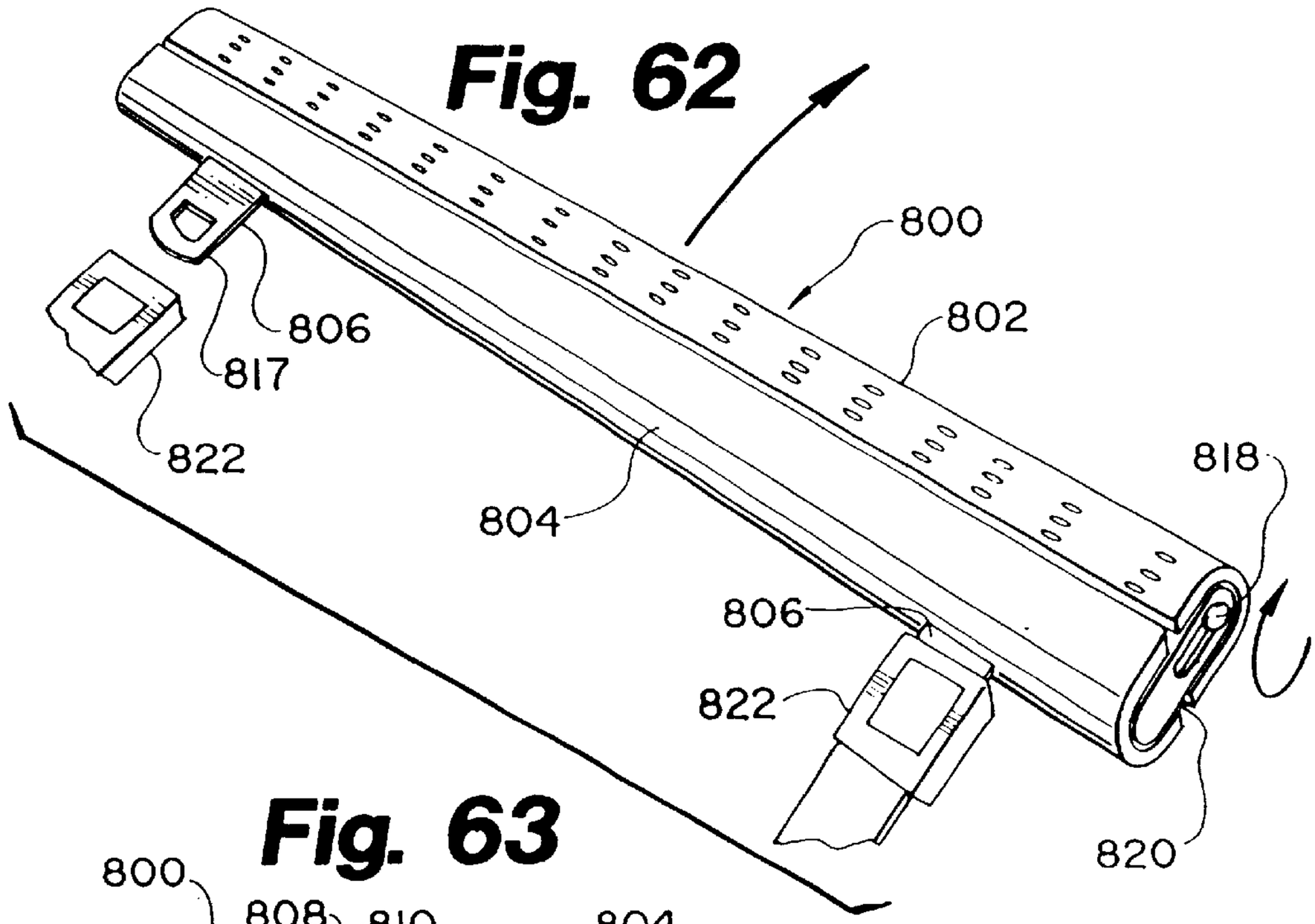

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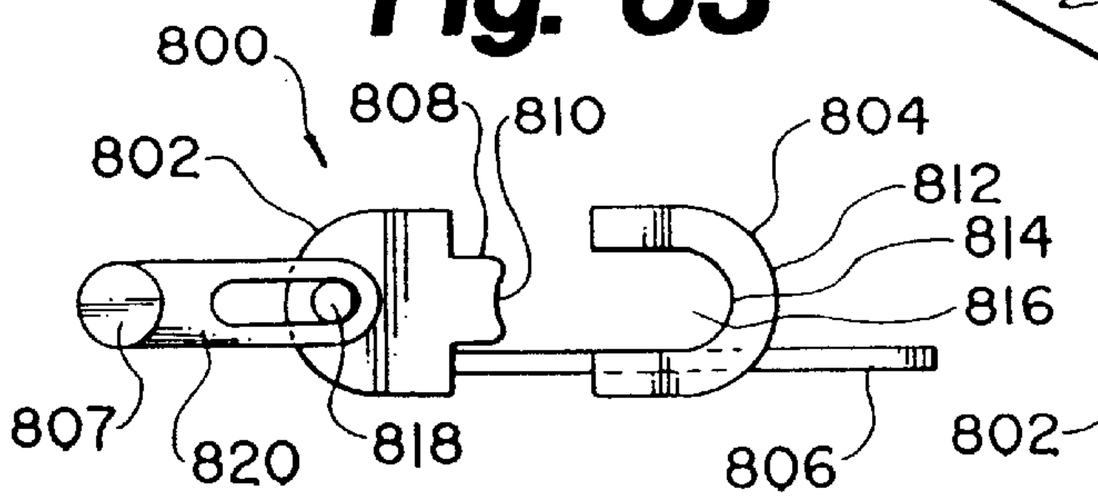
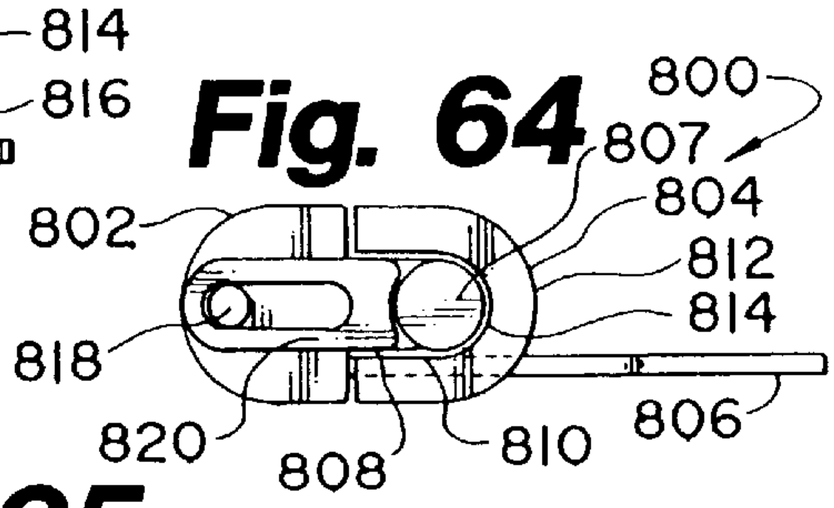


Fig. 64



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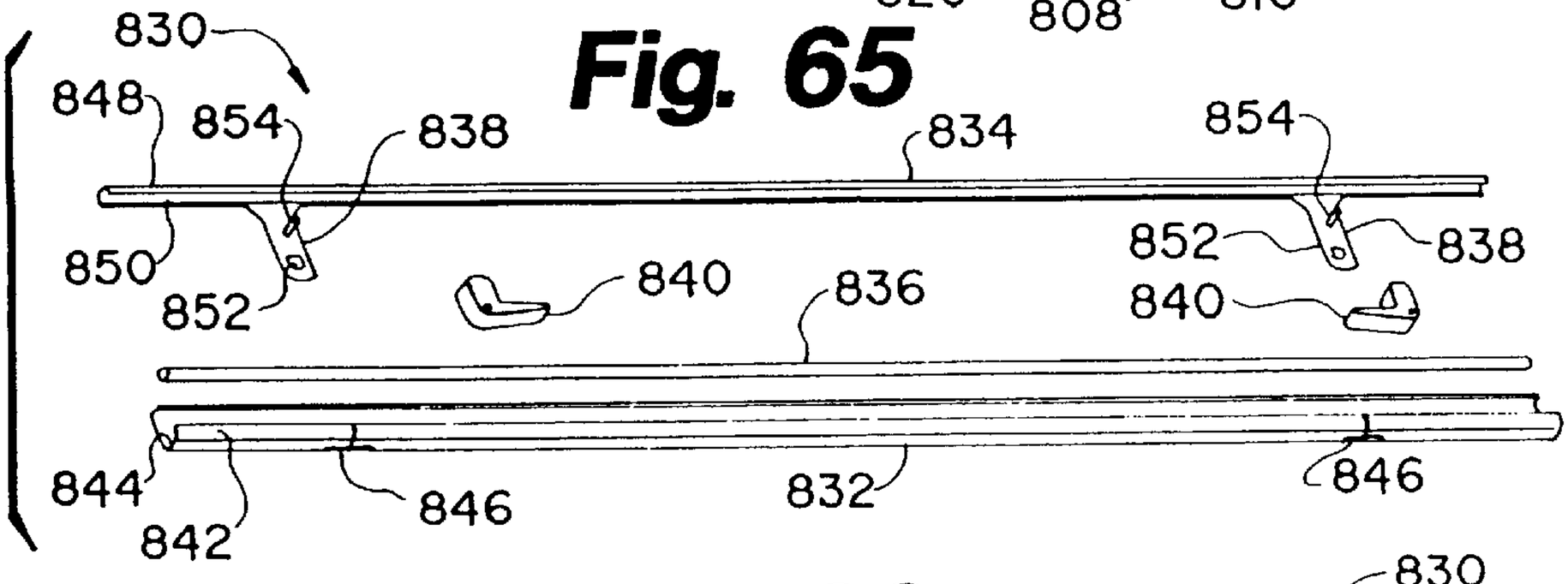

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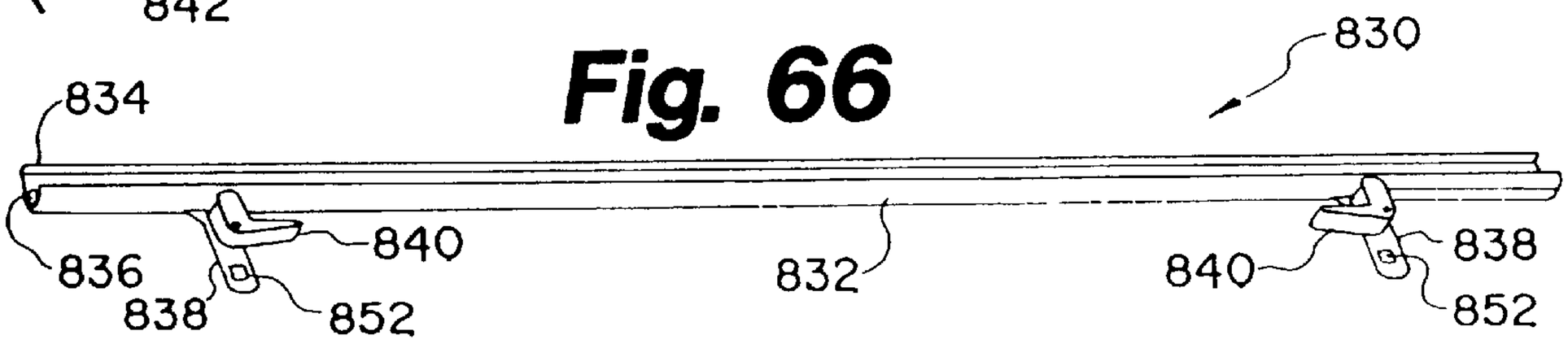

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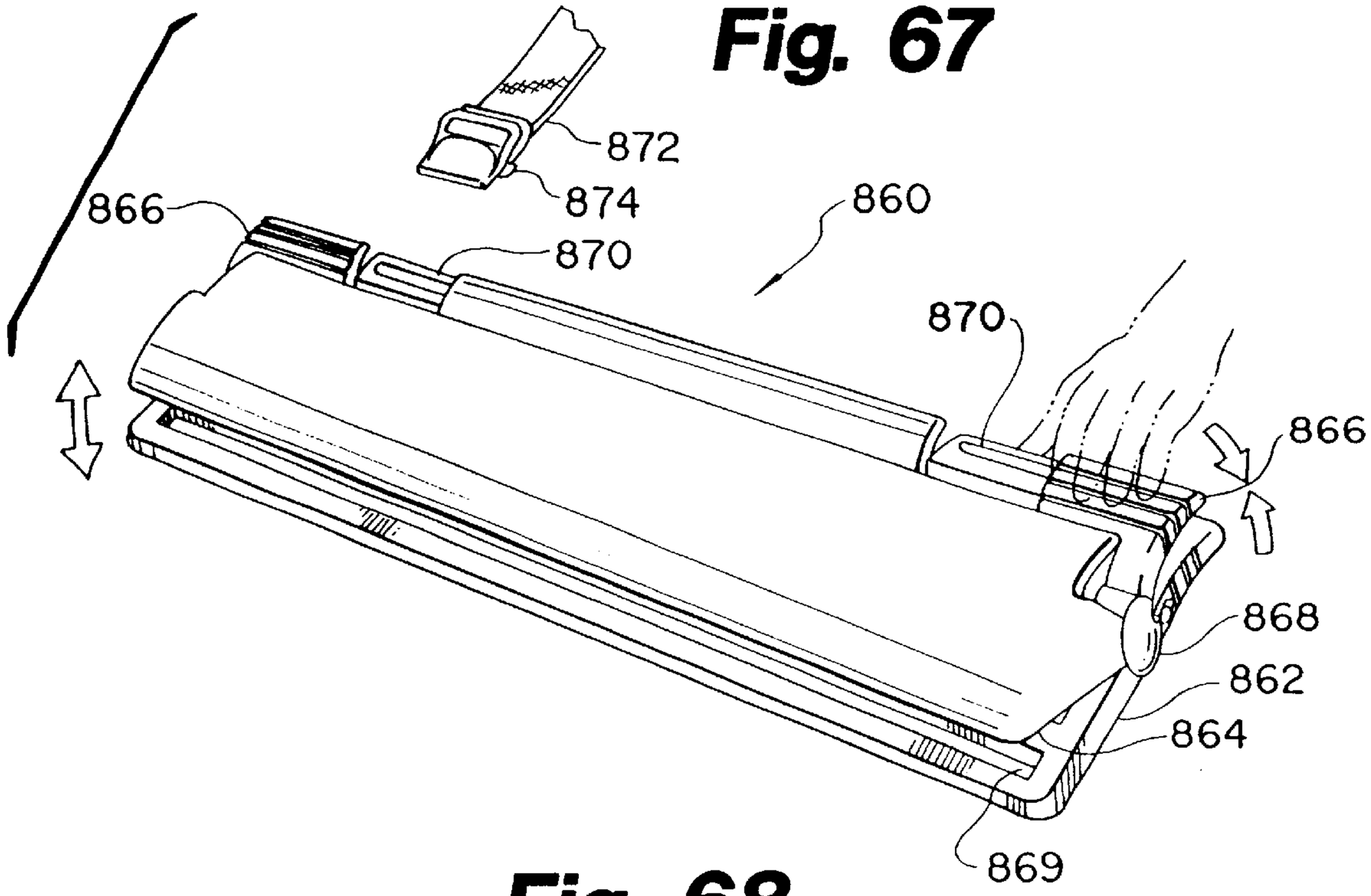

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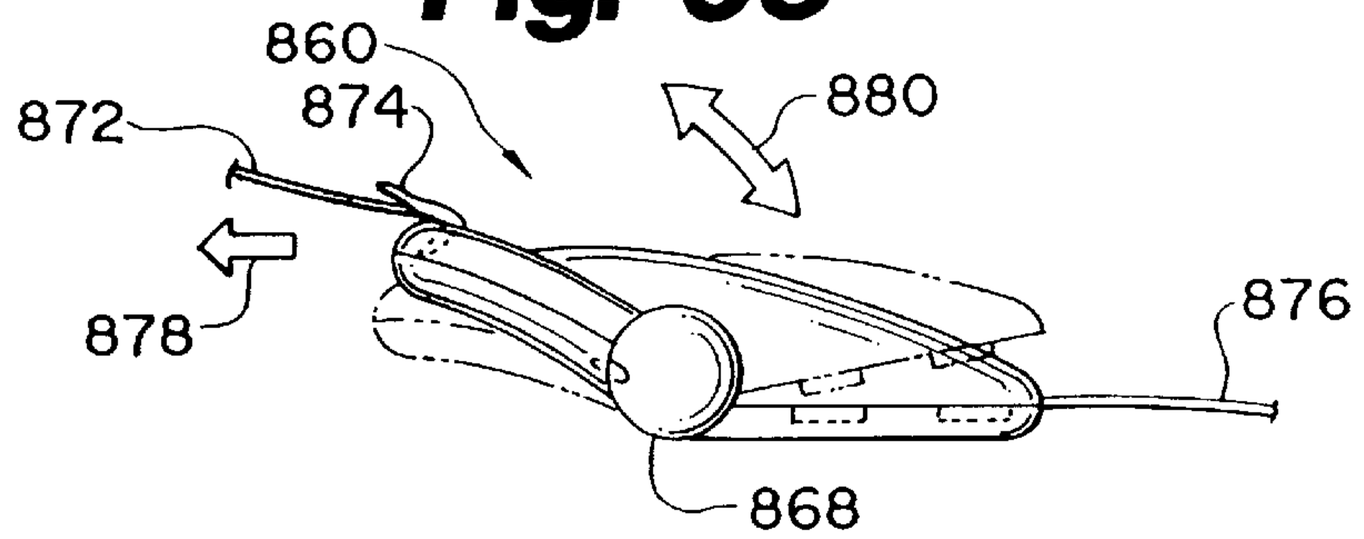

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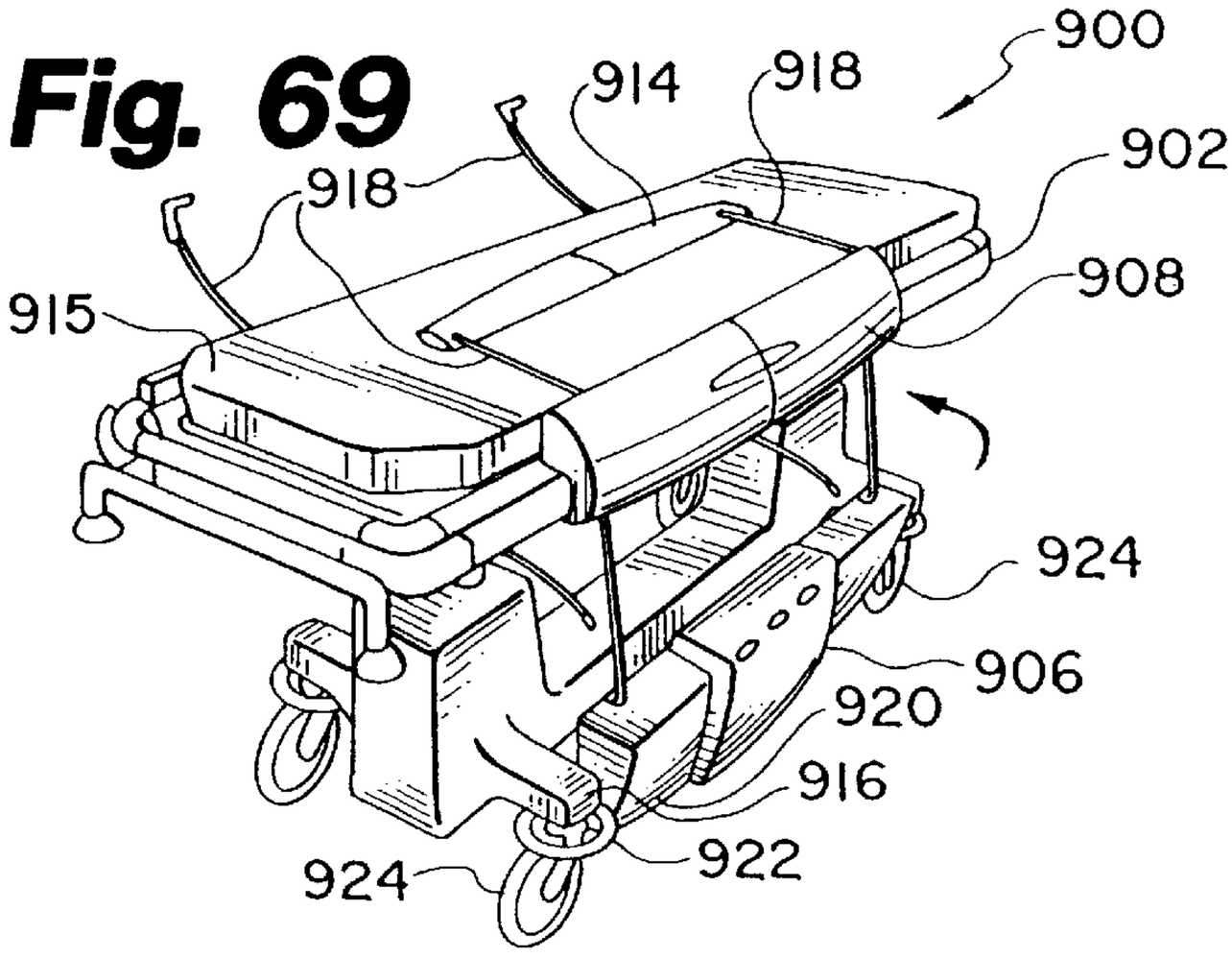

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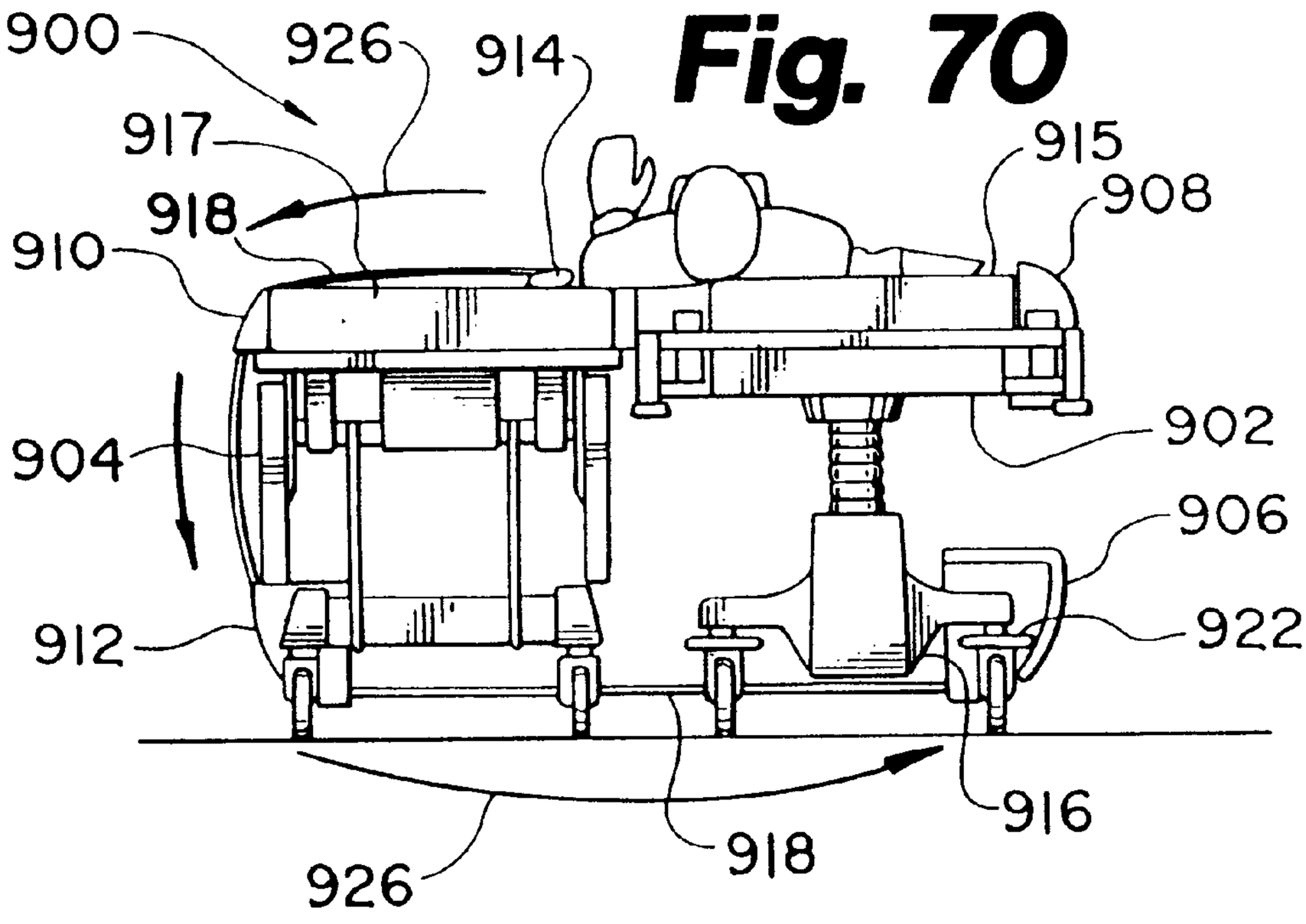
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Fig. 71

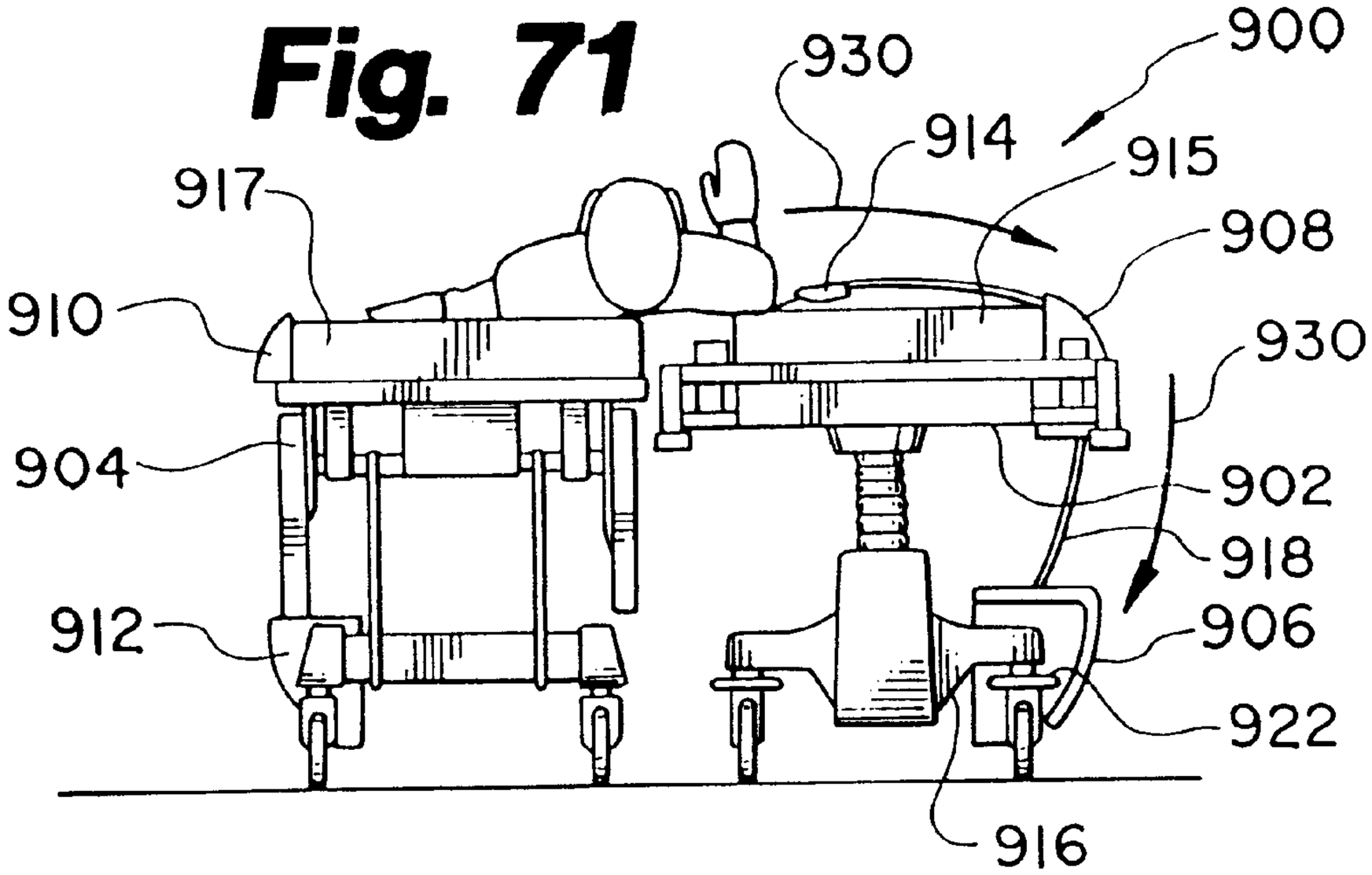
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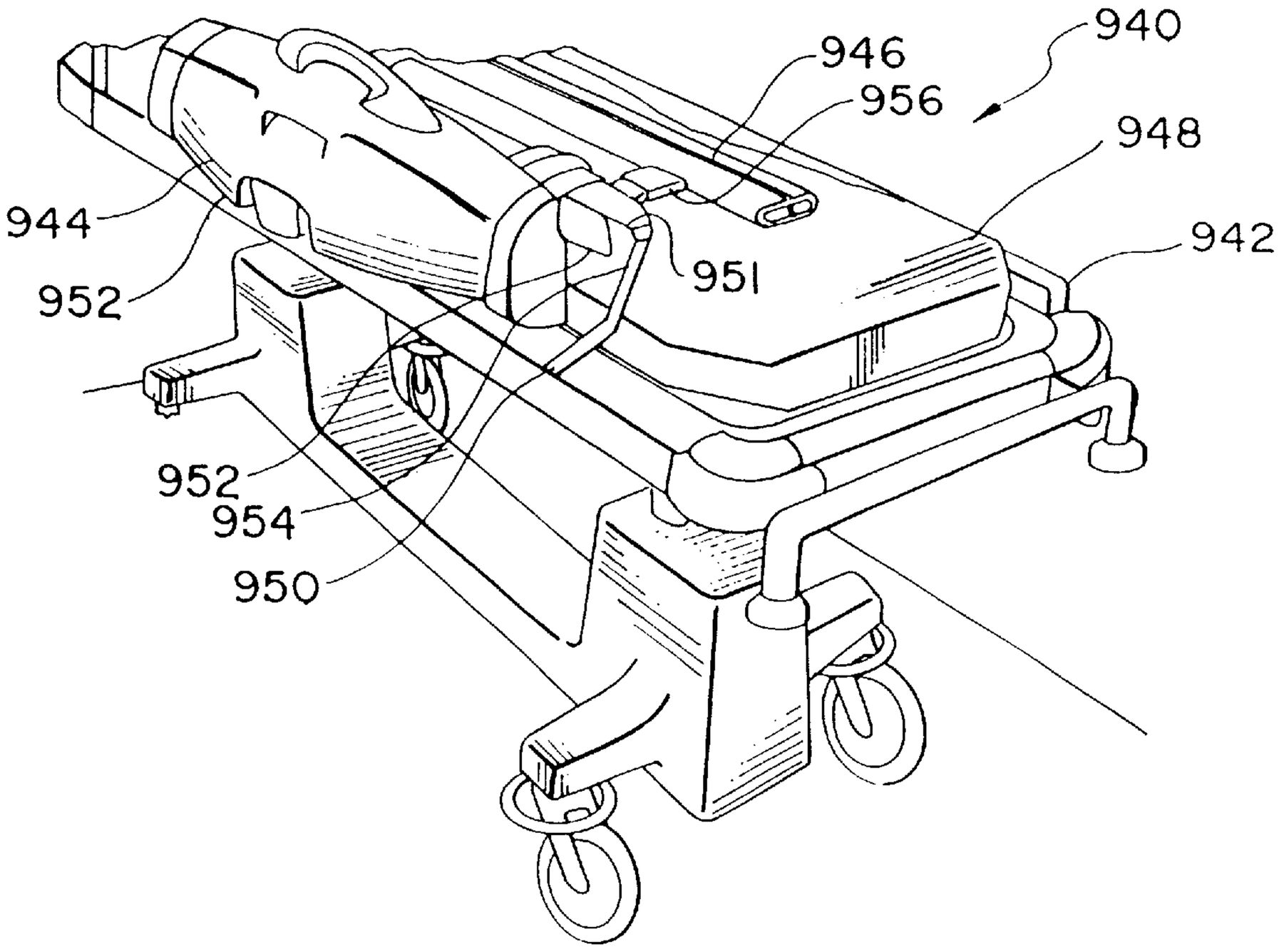
Fig. 72



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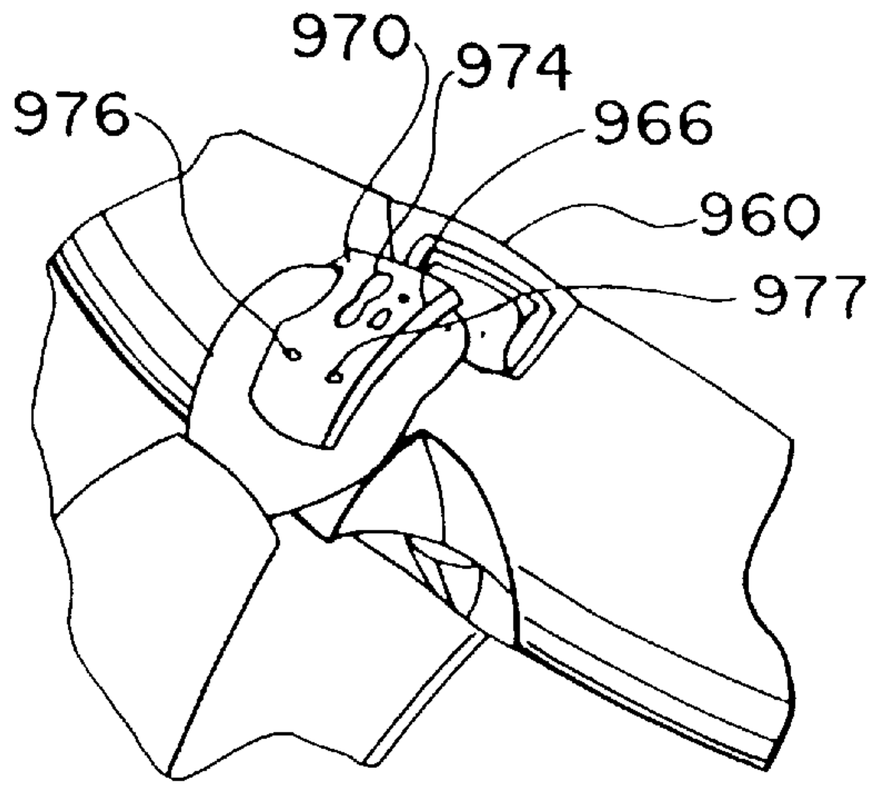

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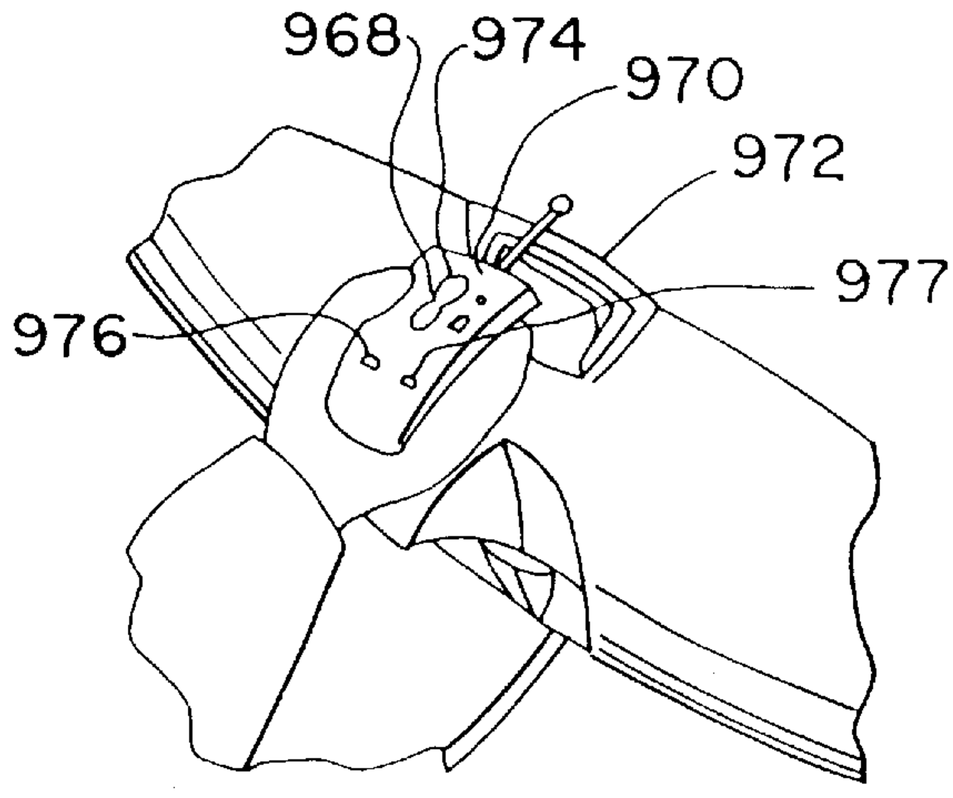
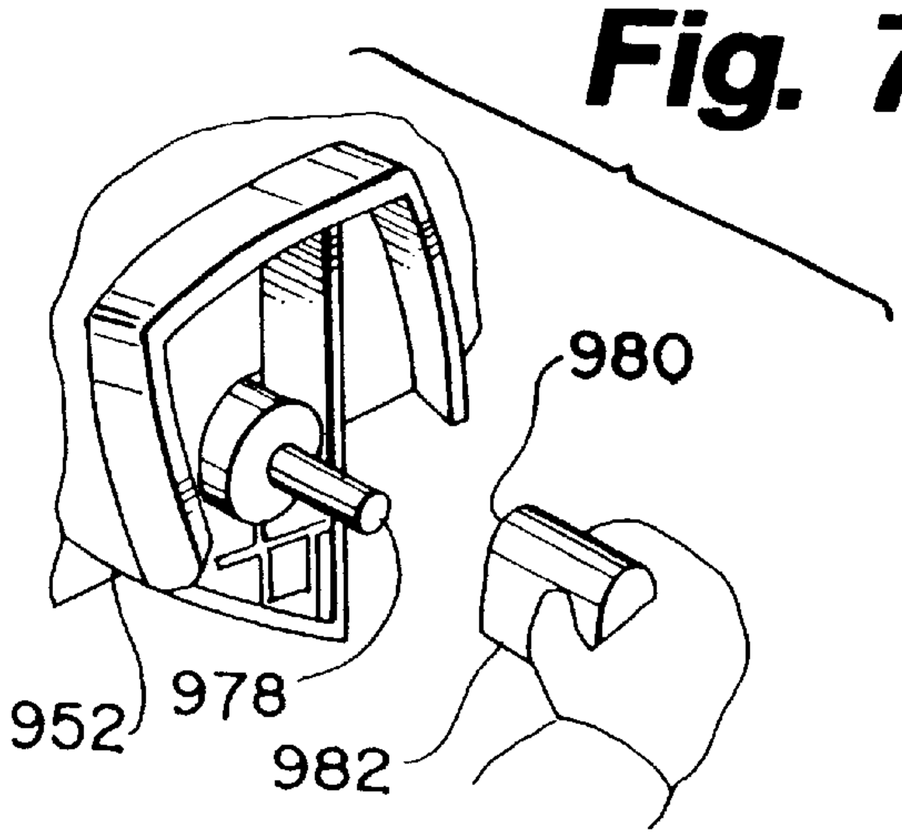


Fig. 75



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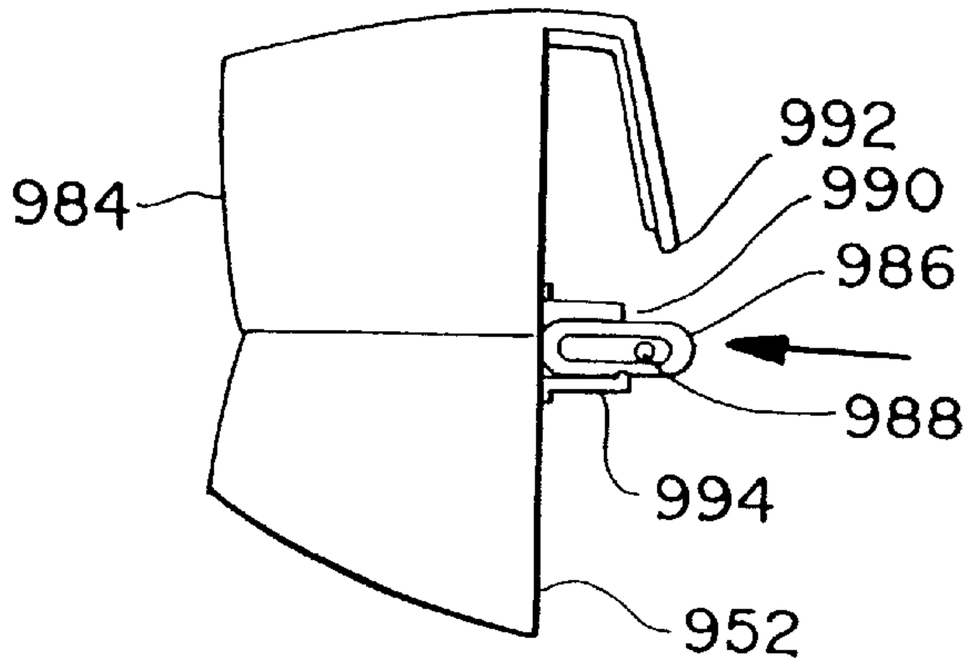
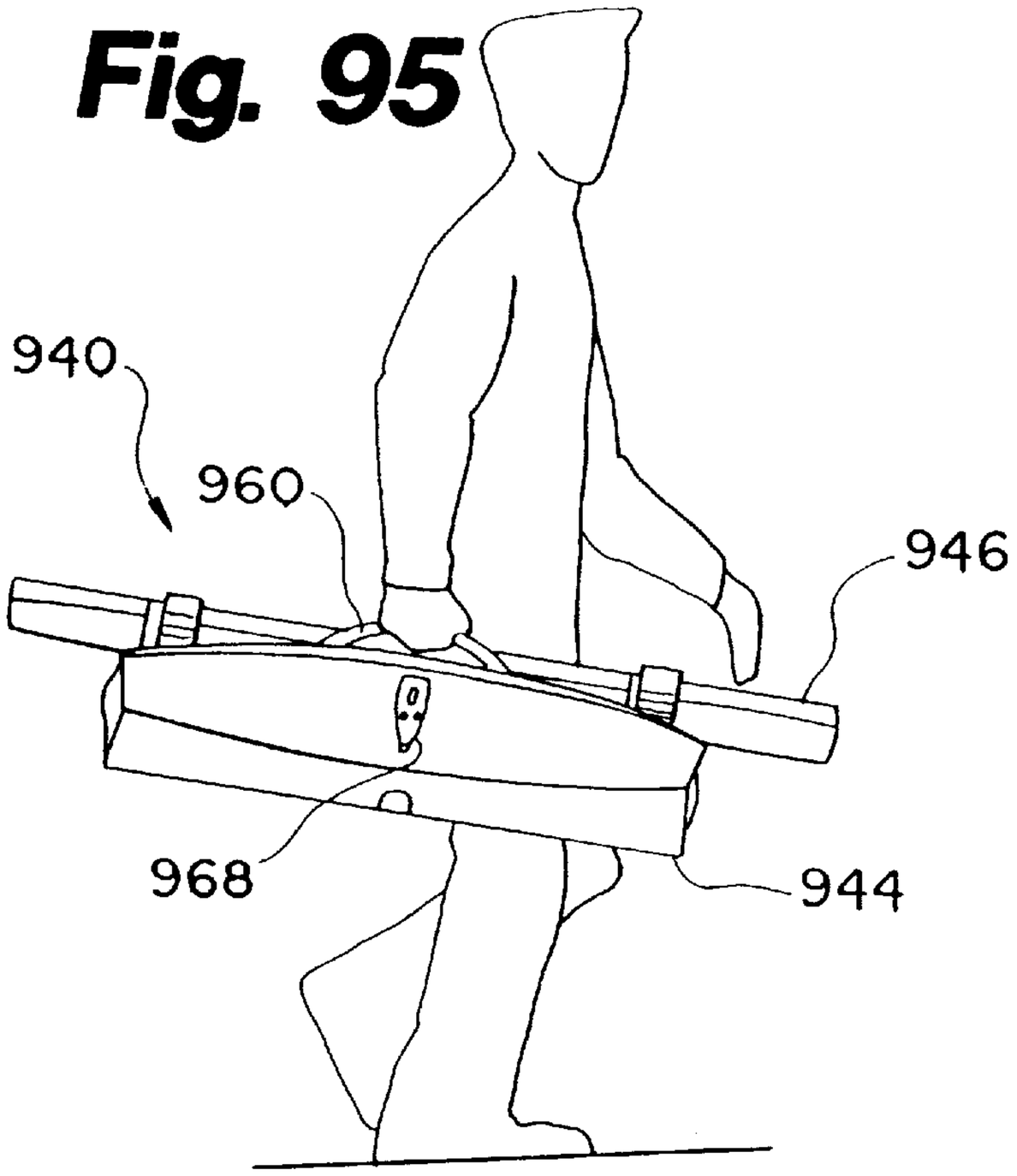


Fig. 95



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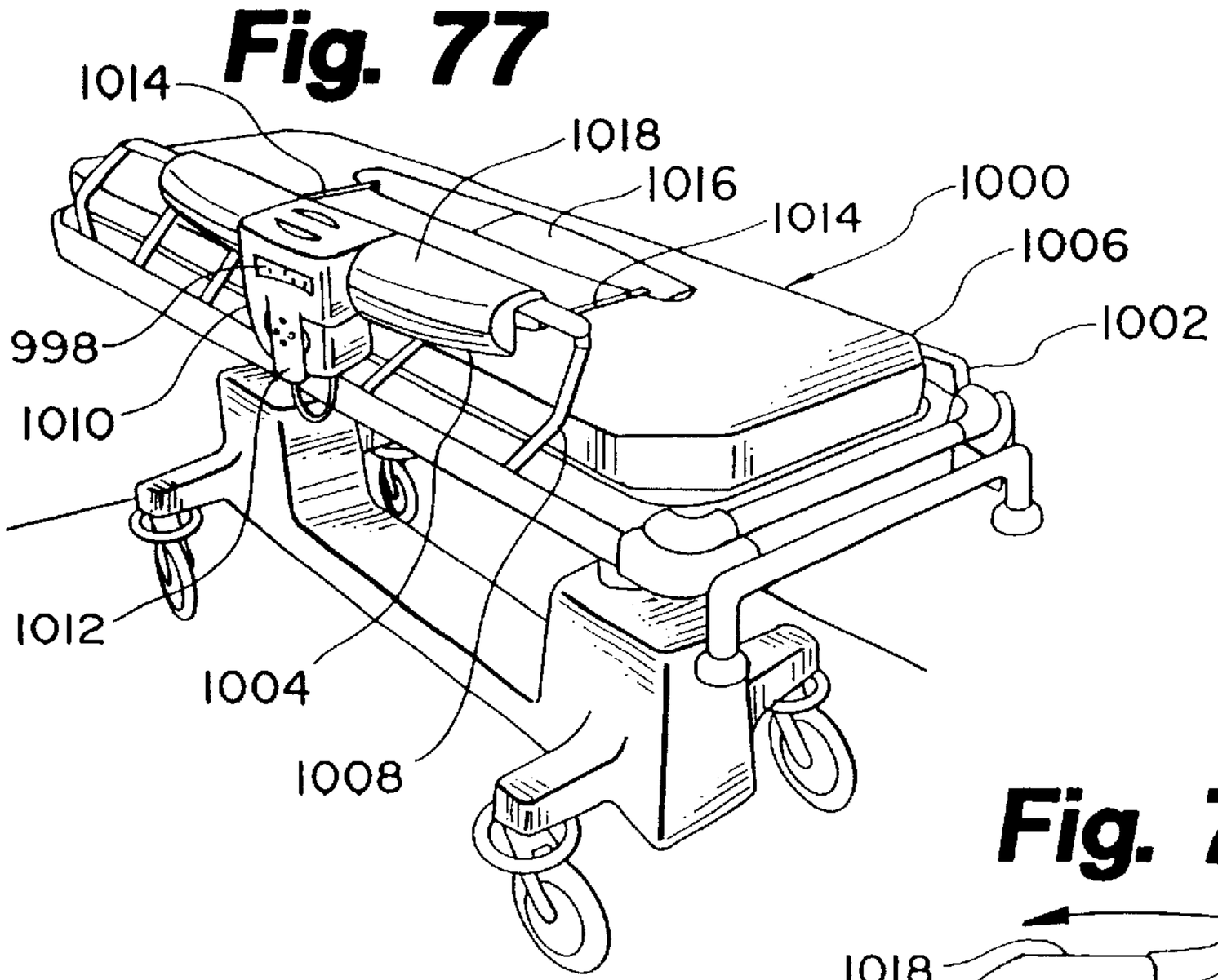

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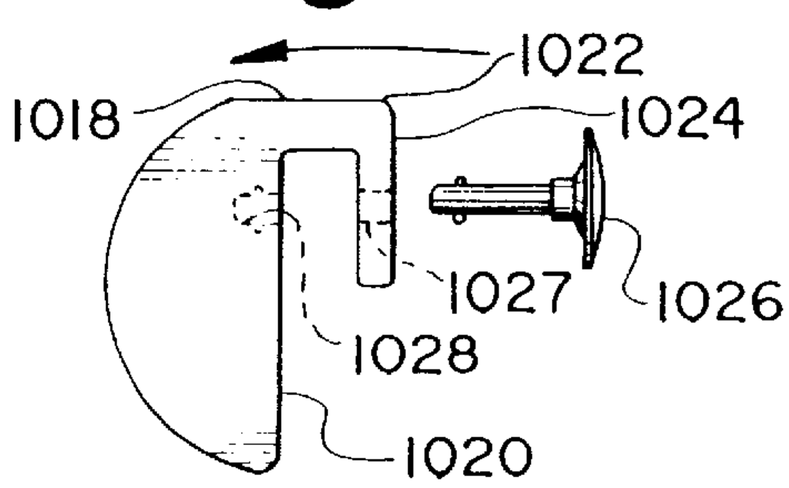

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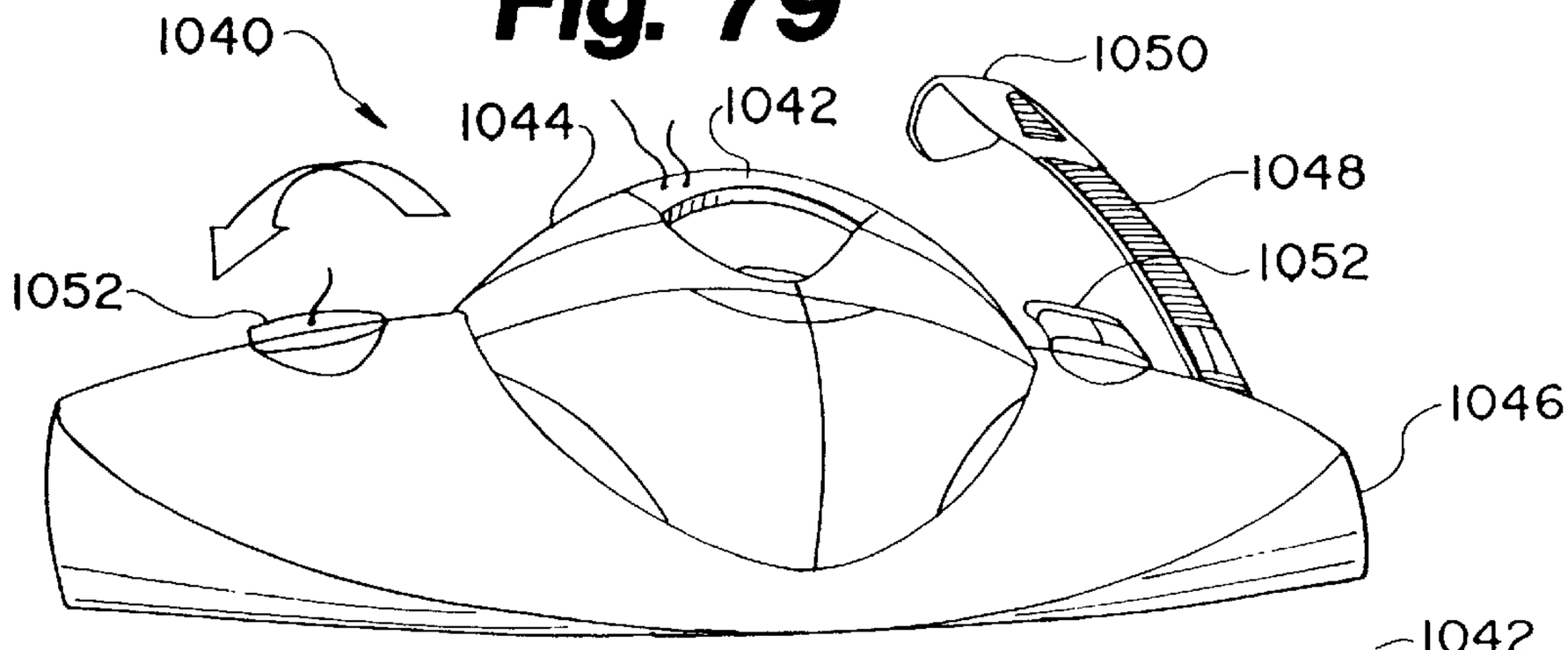

Fig. 80

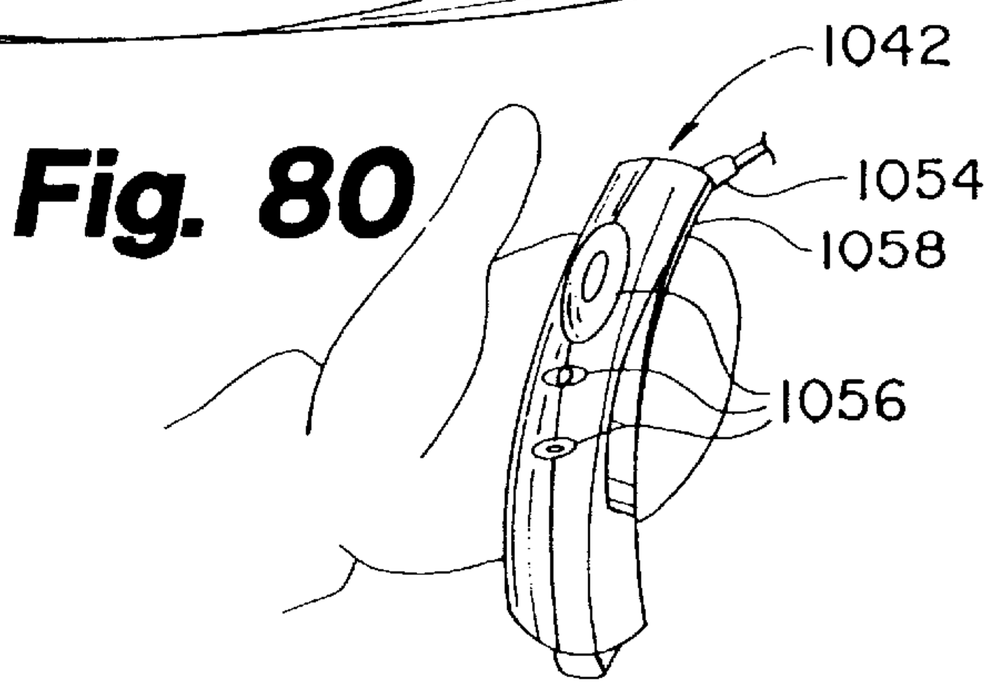

Fig. 81

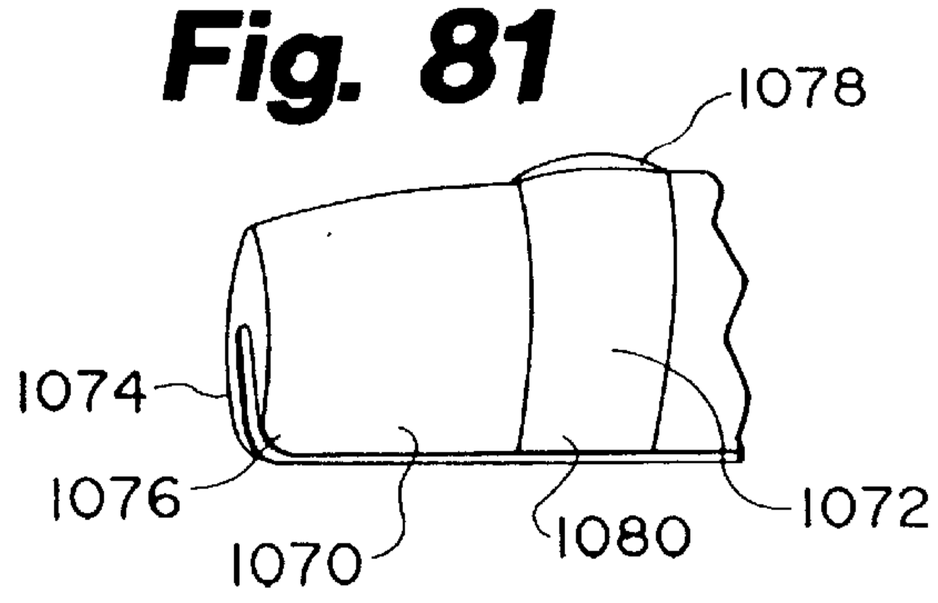

Fig. 82

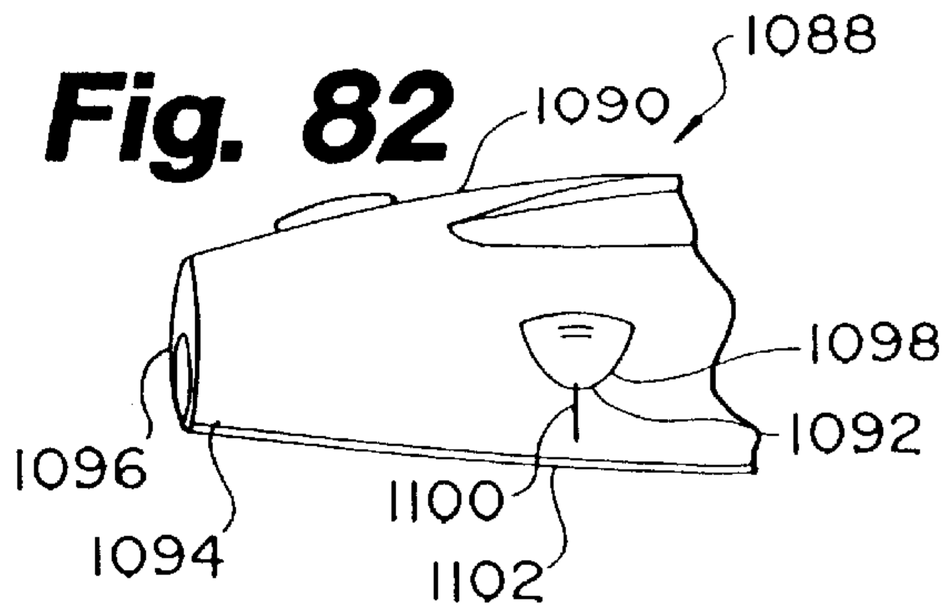

Fig. 83

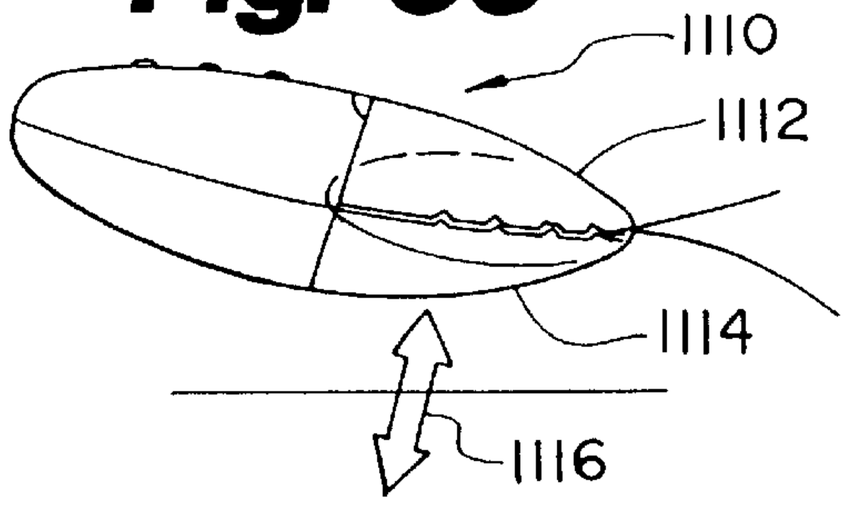

Fig. 84

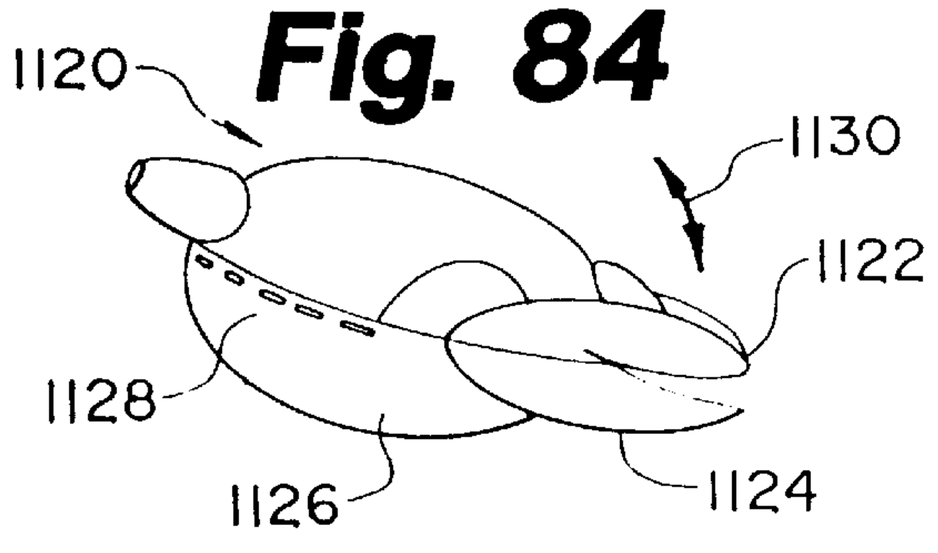

Fig. 85

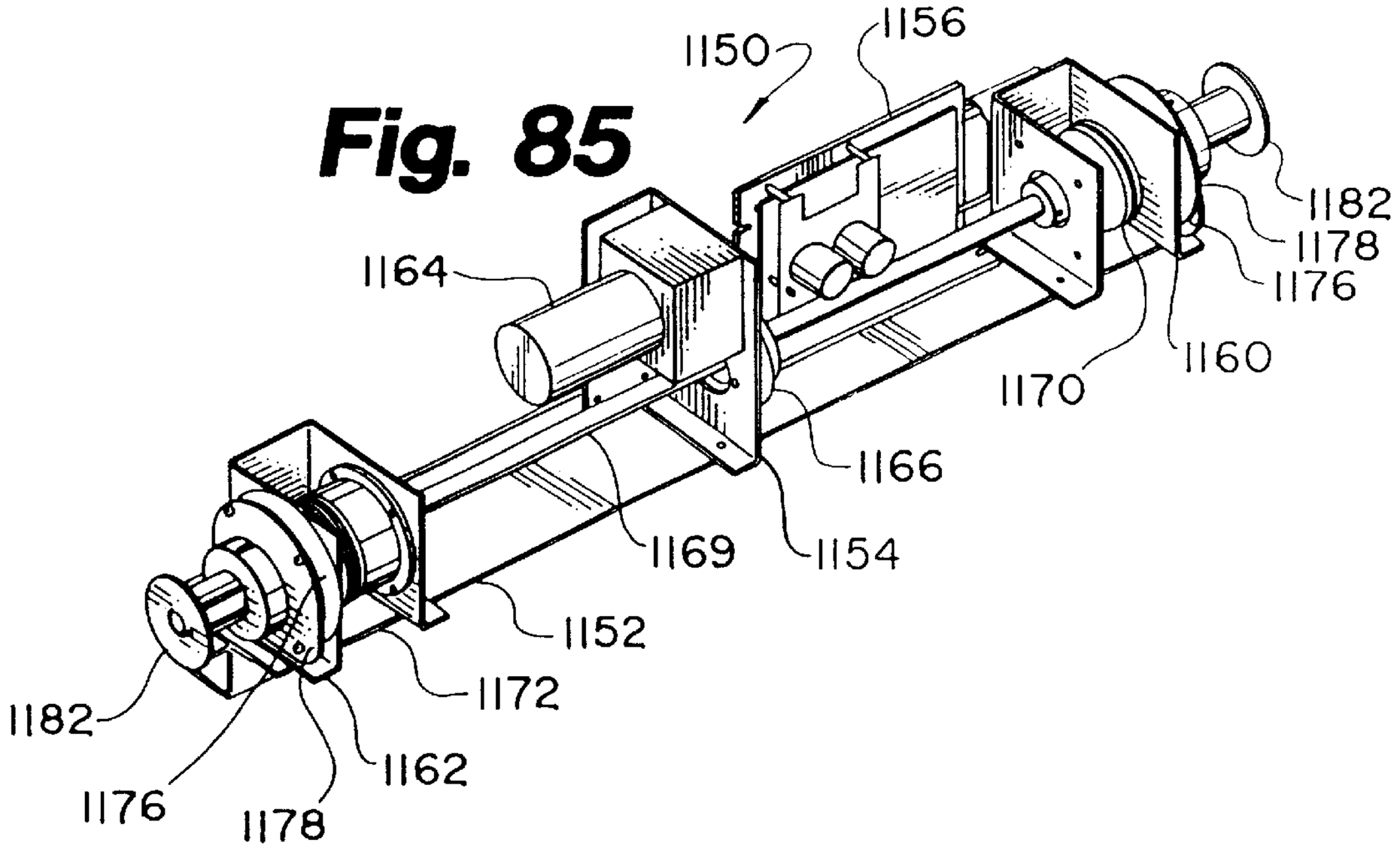

Fig. 86

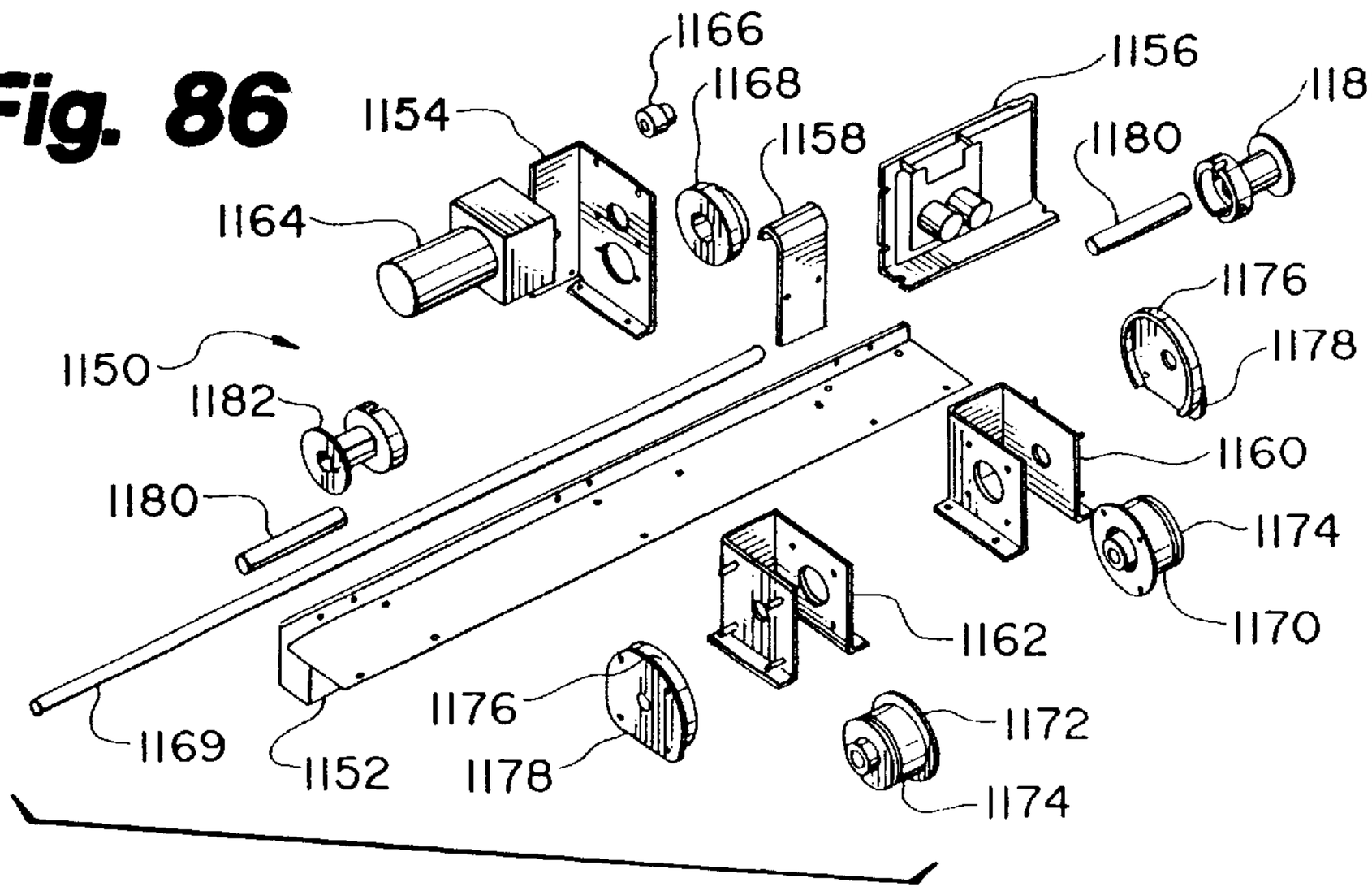

Fig. 87

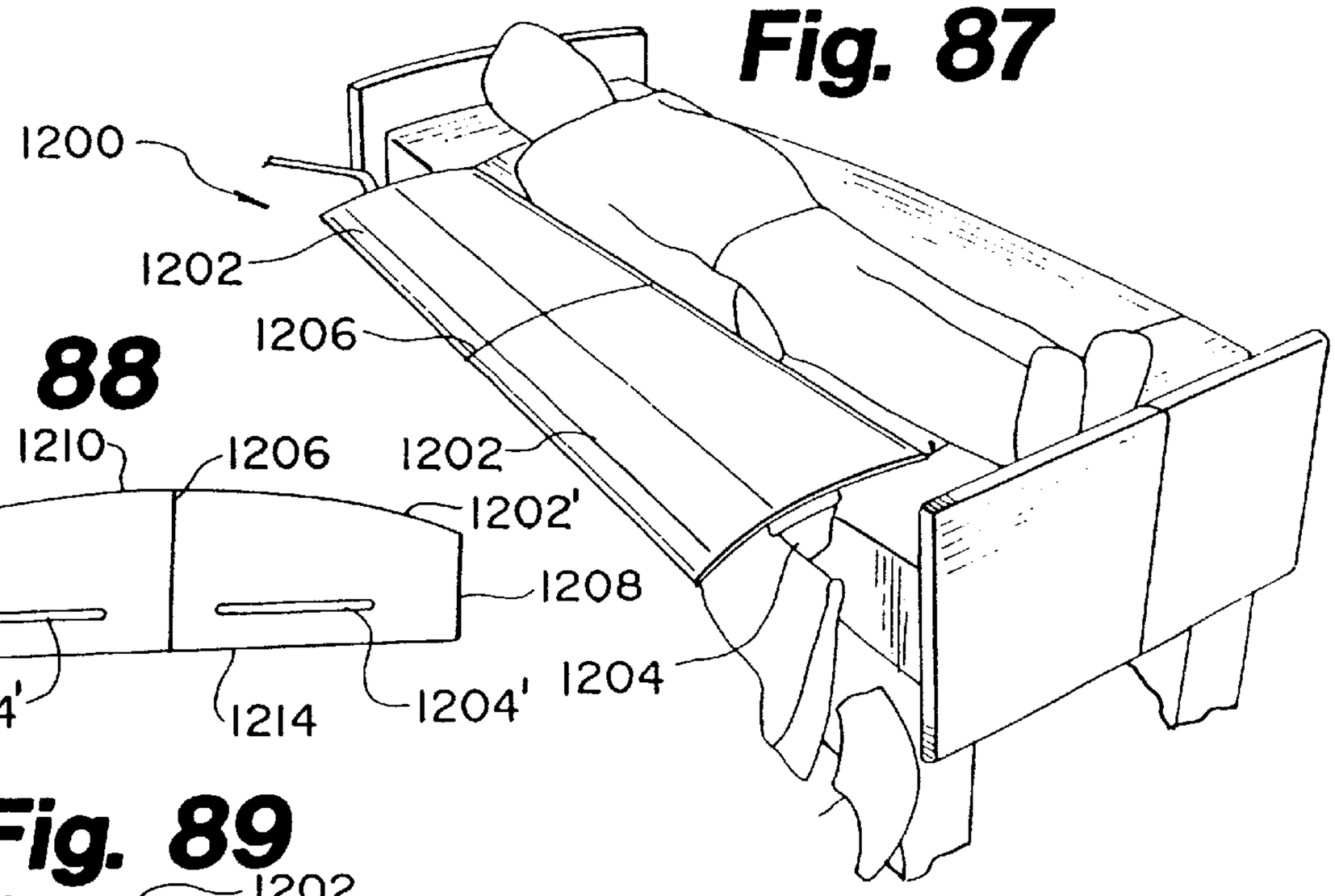

Fig. 88

Fig. 89

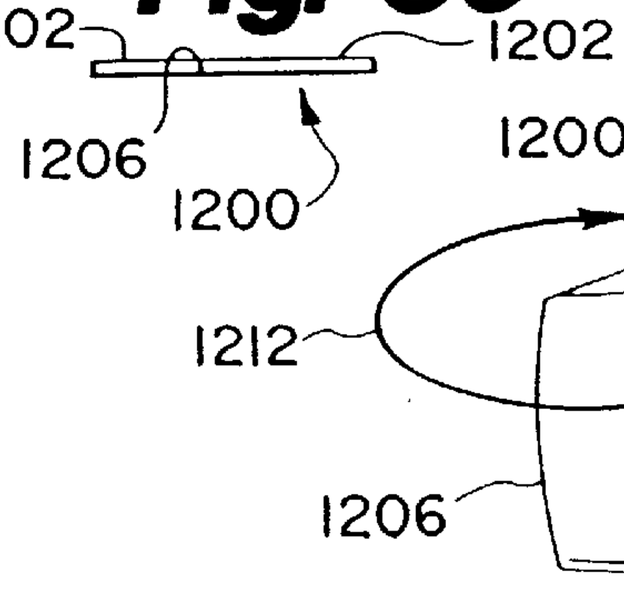

Fig. 90

Fig. 91

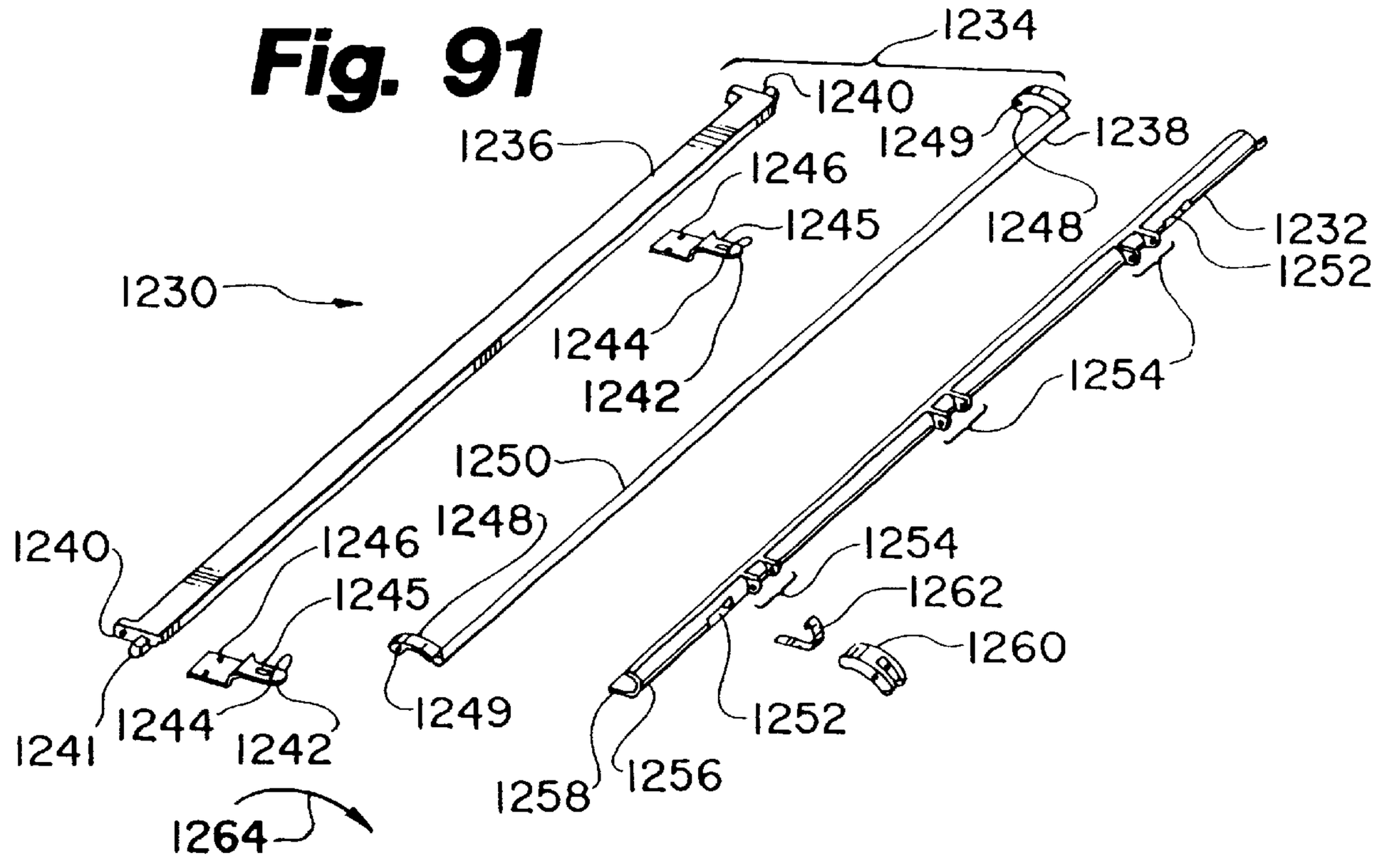
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Fig. 92

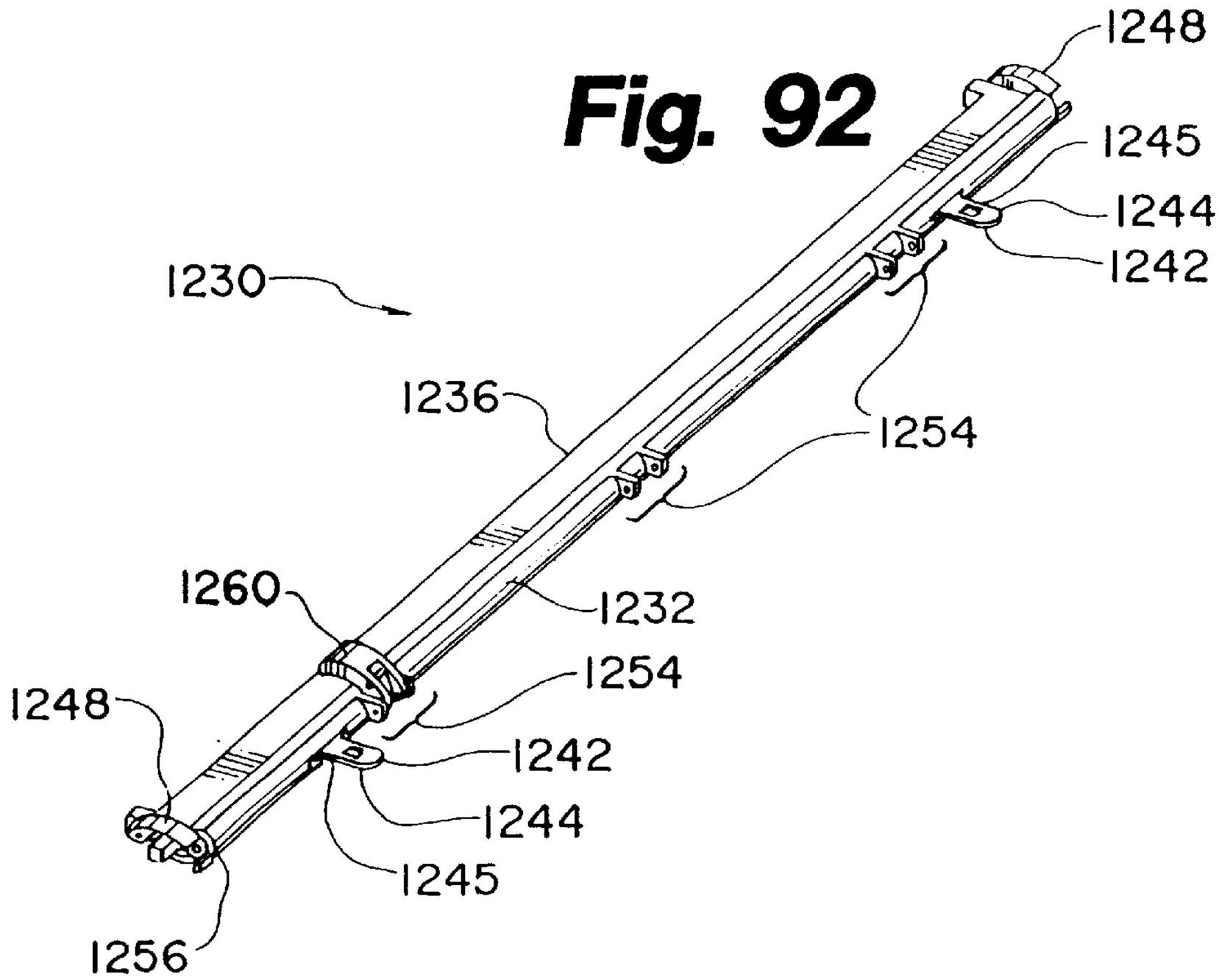
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Fig. 93

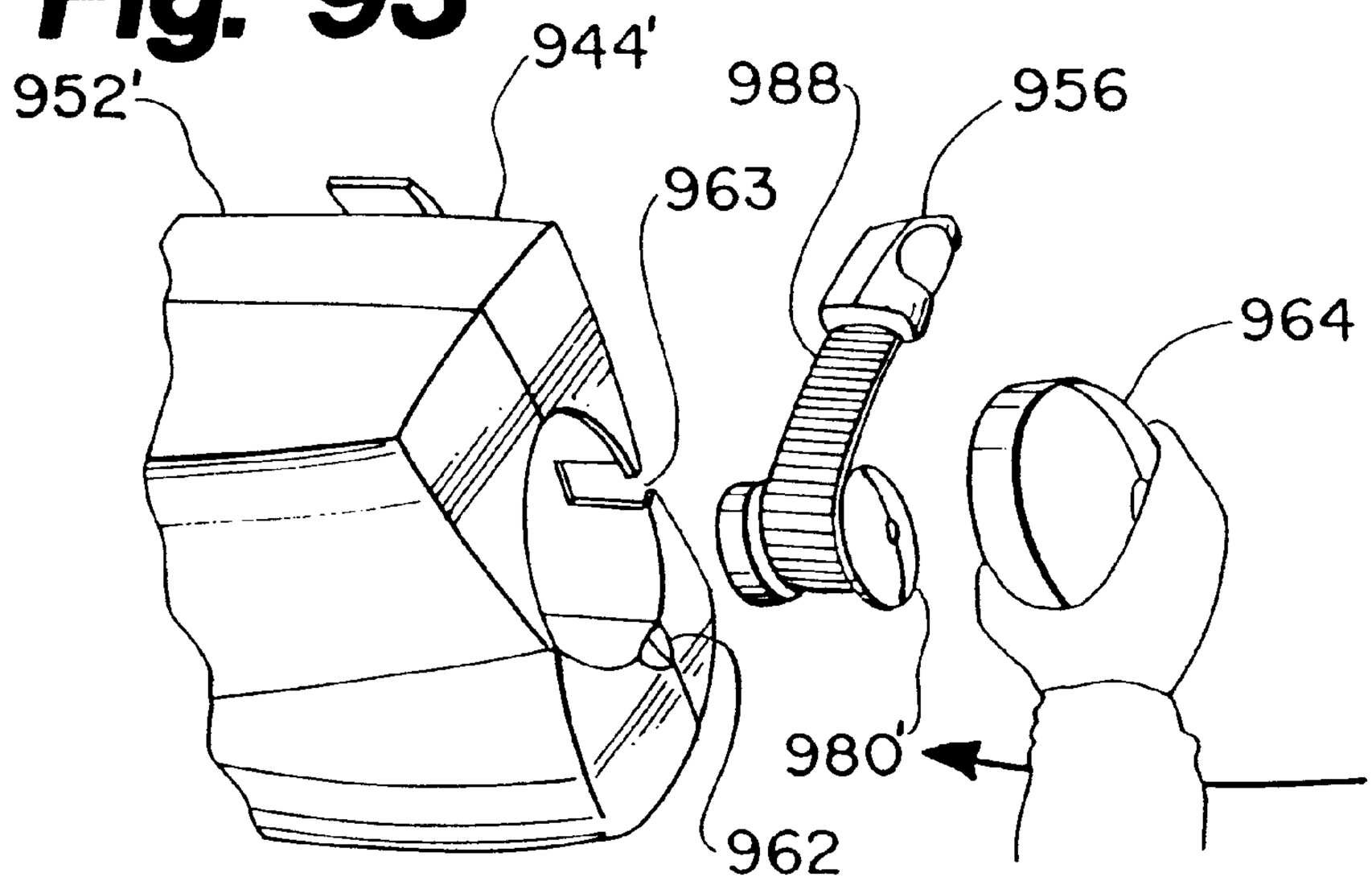
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Fig. 94

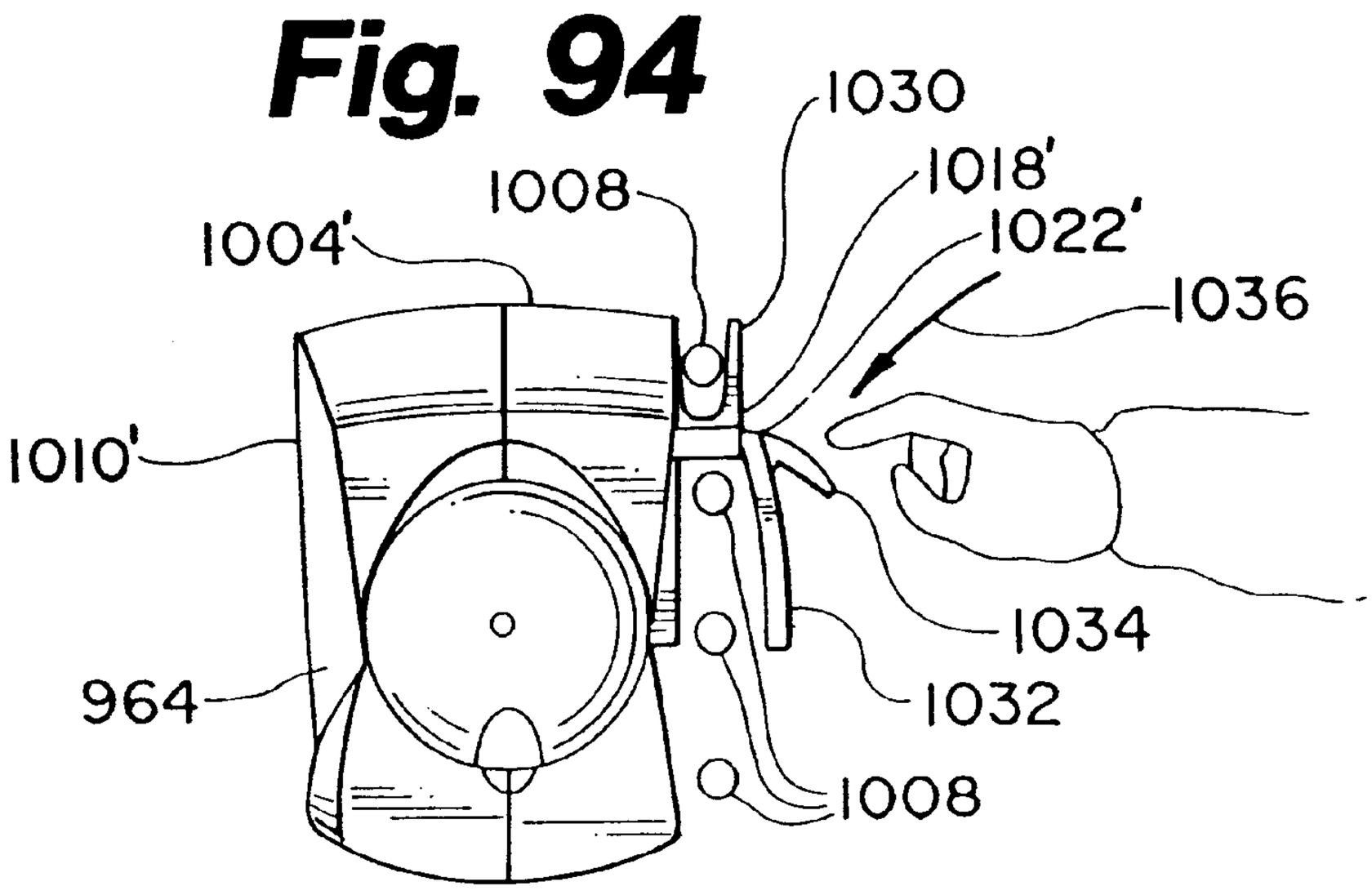
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FIG. 96

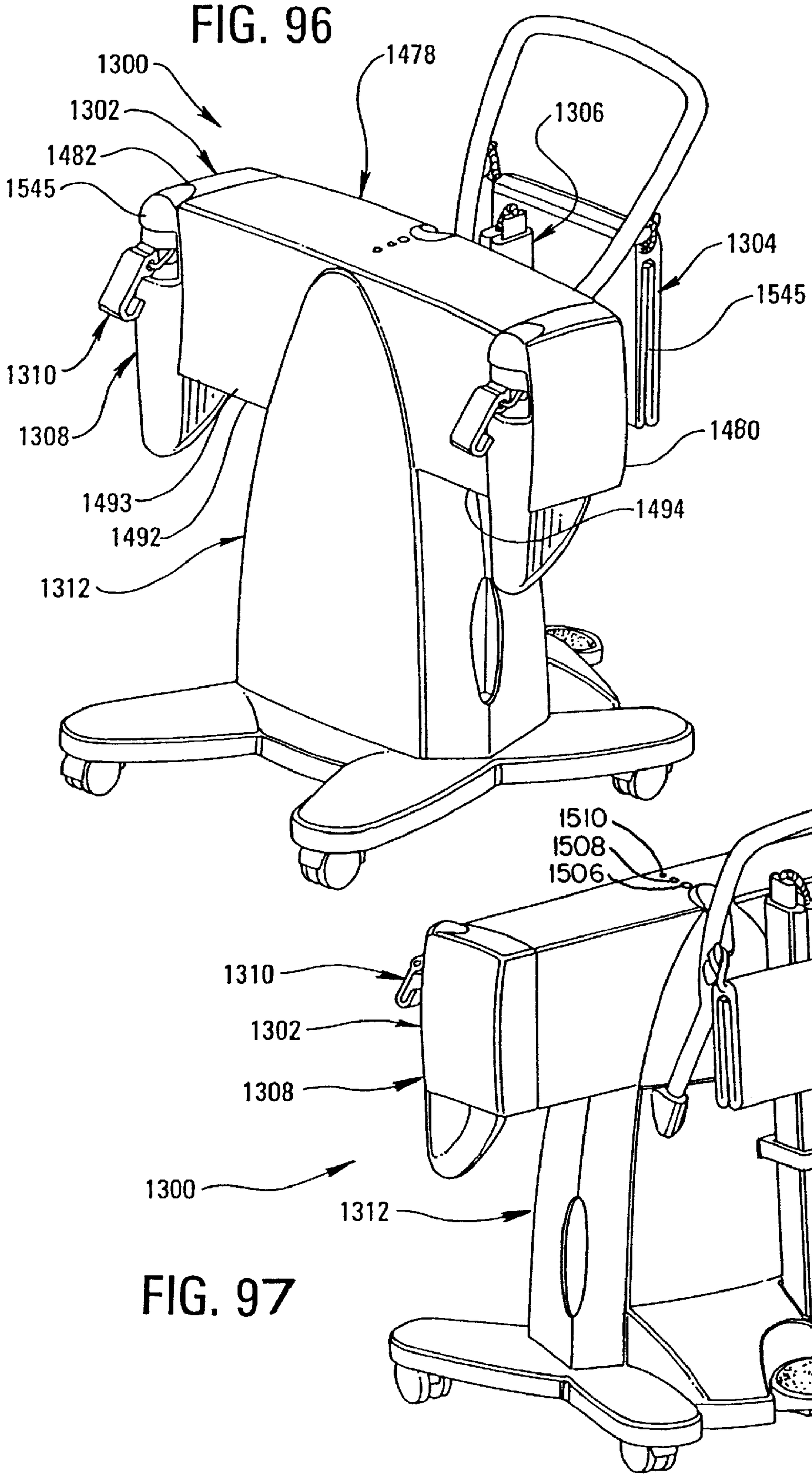
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FIG. 97

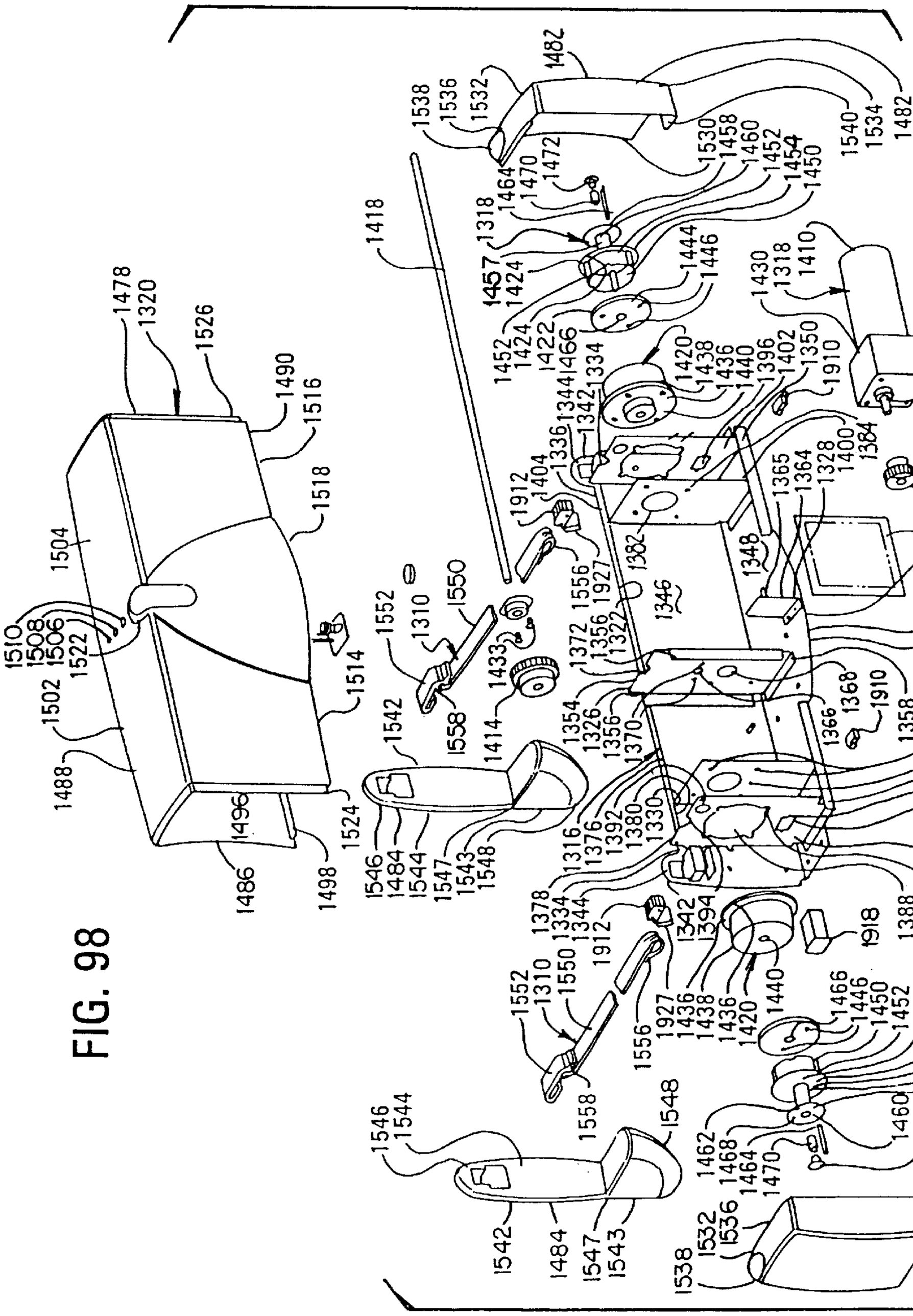
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FIG. 98

FIG. 99

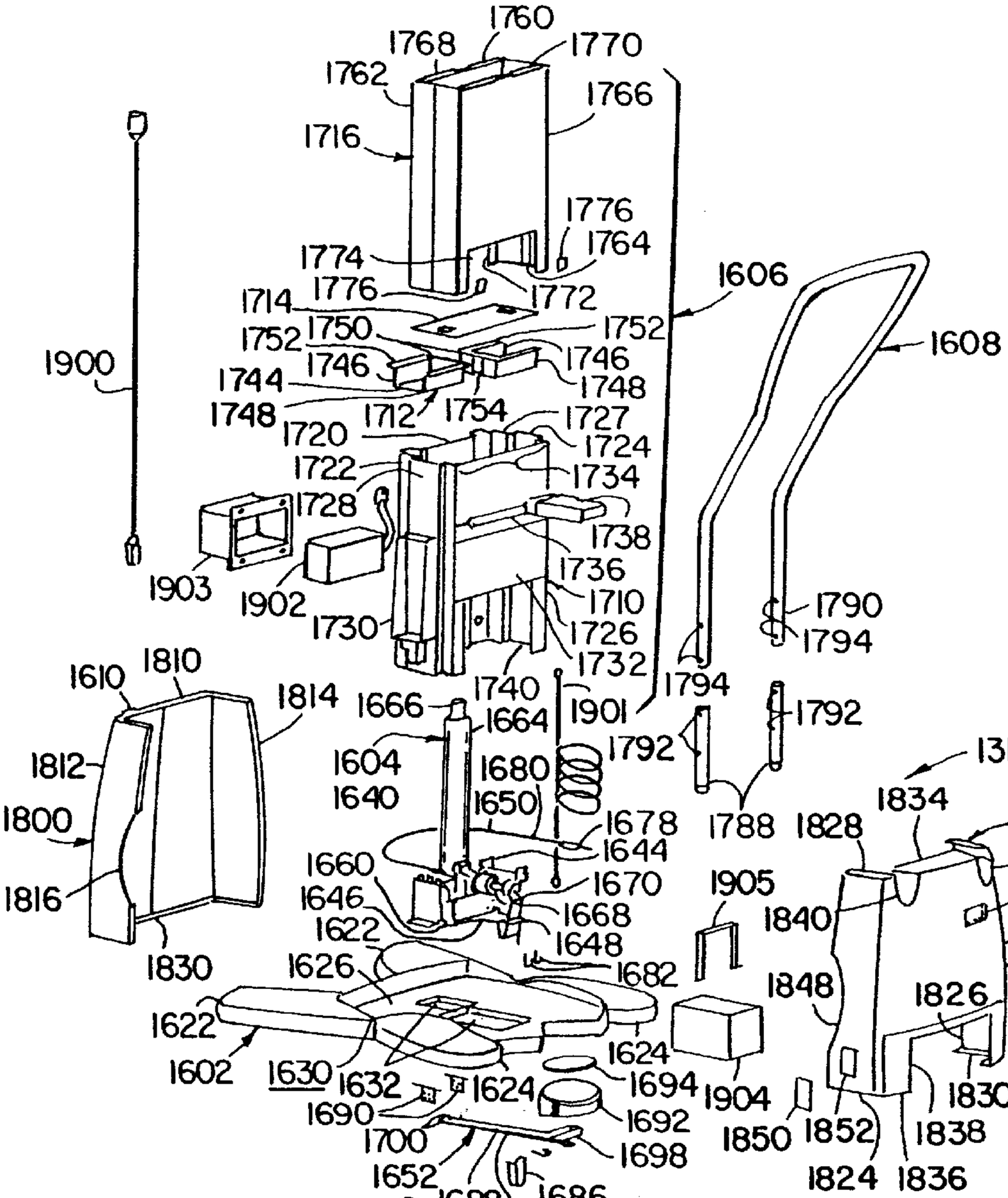
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FIG. 100

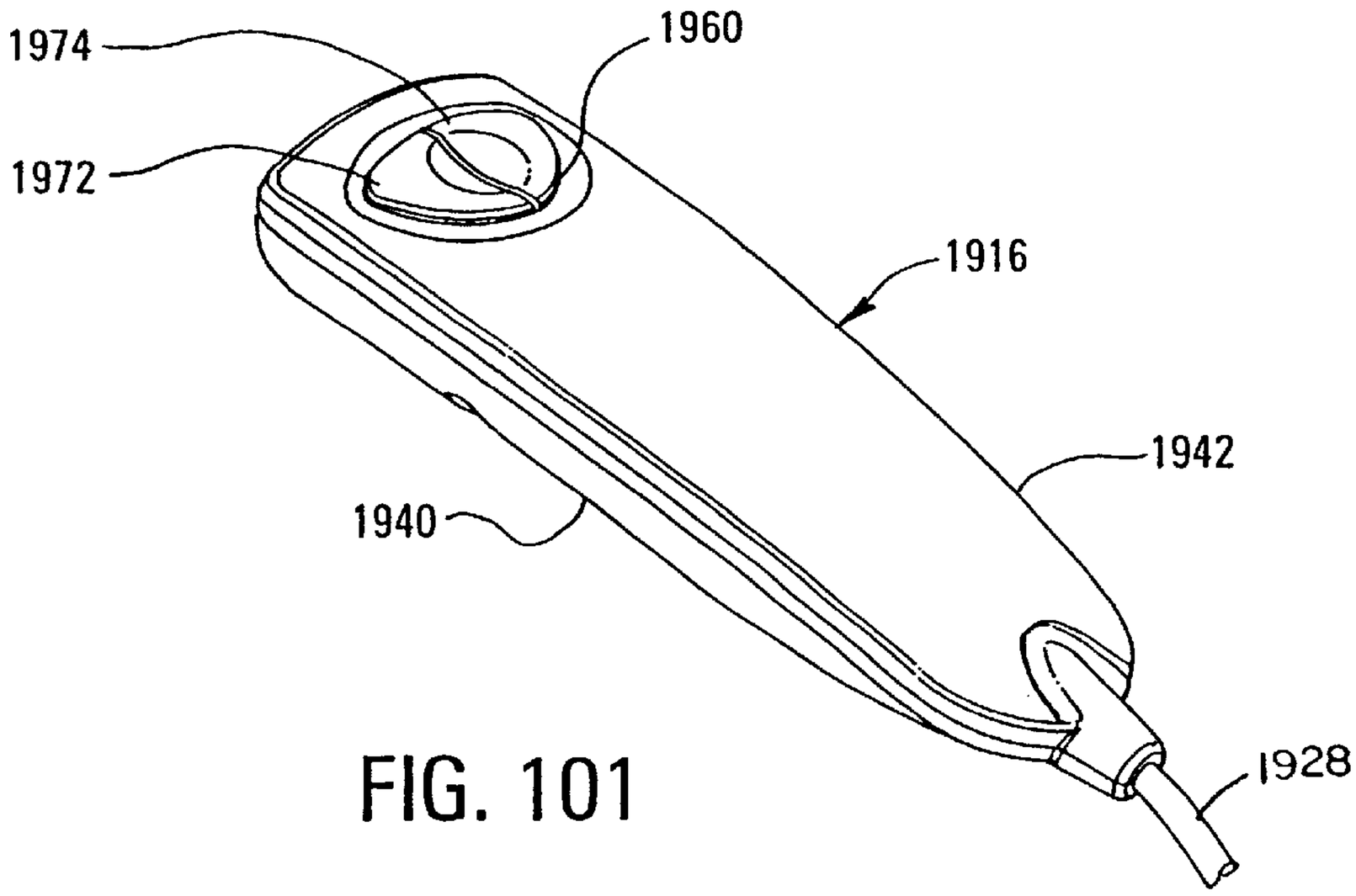


FIG. 101

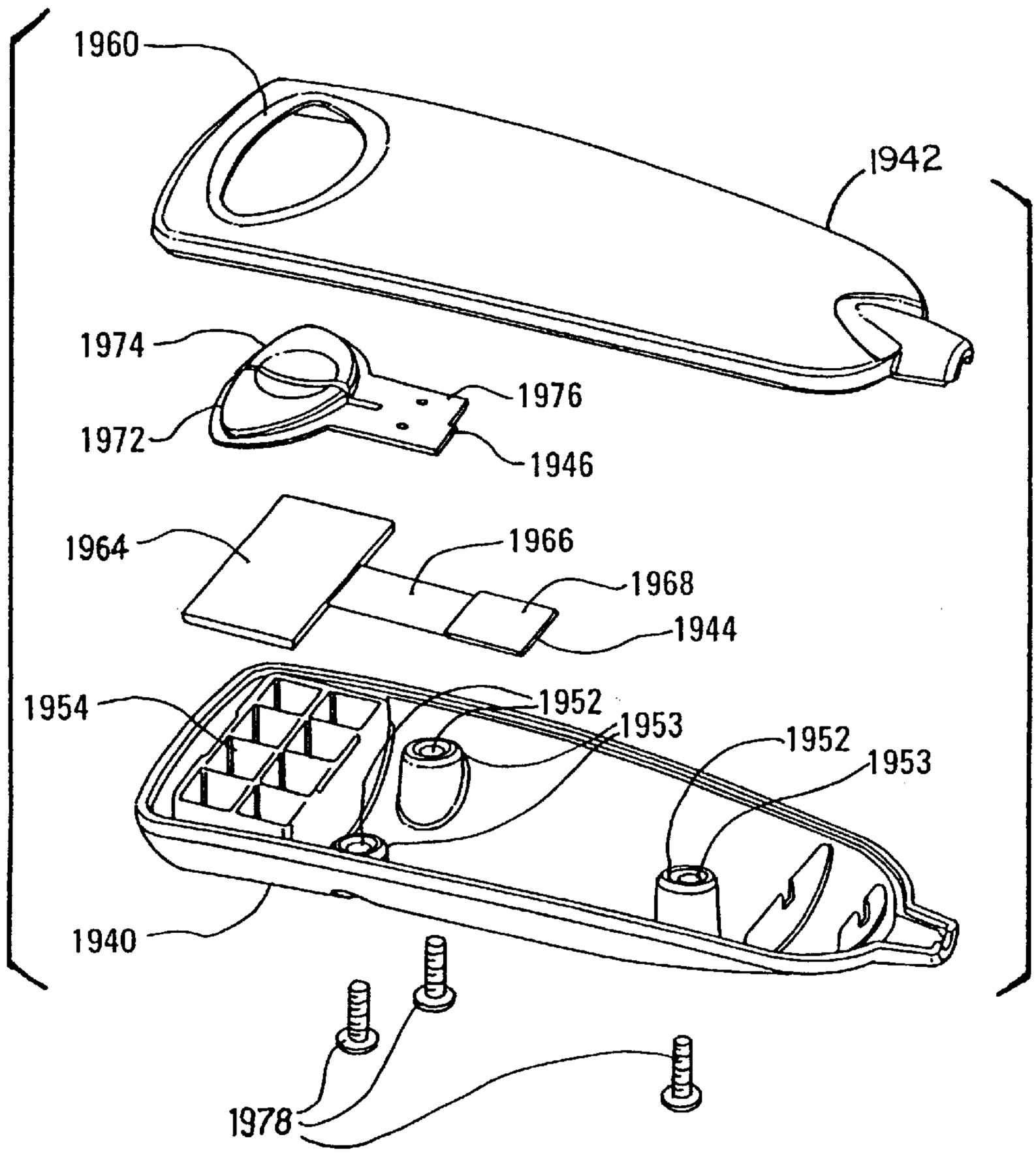


FIG. 102

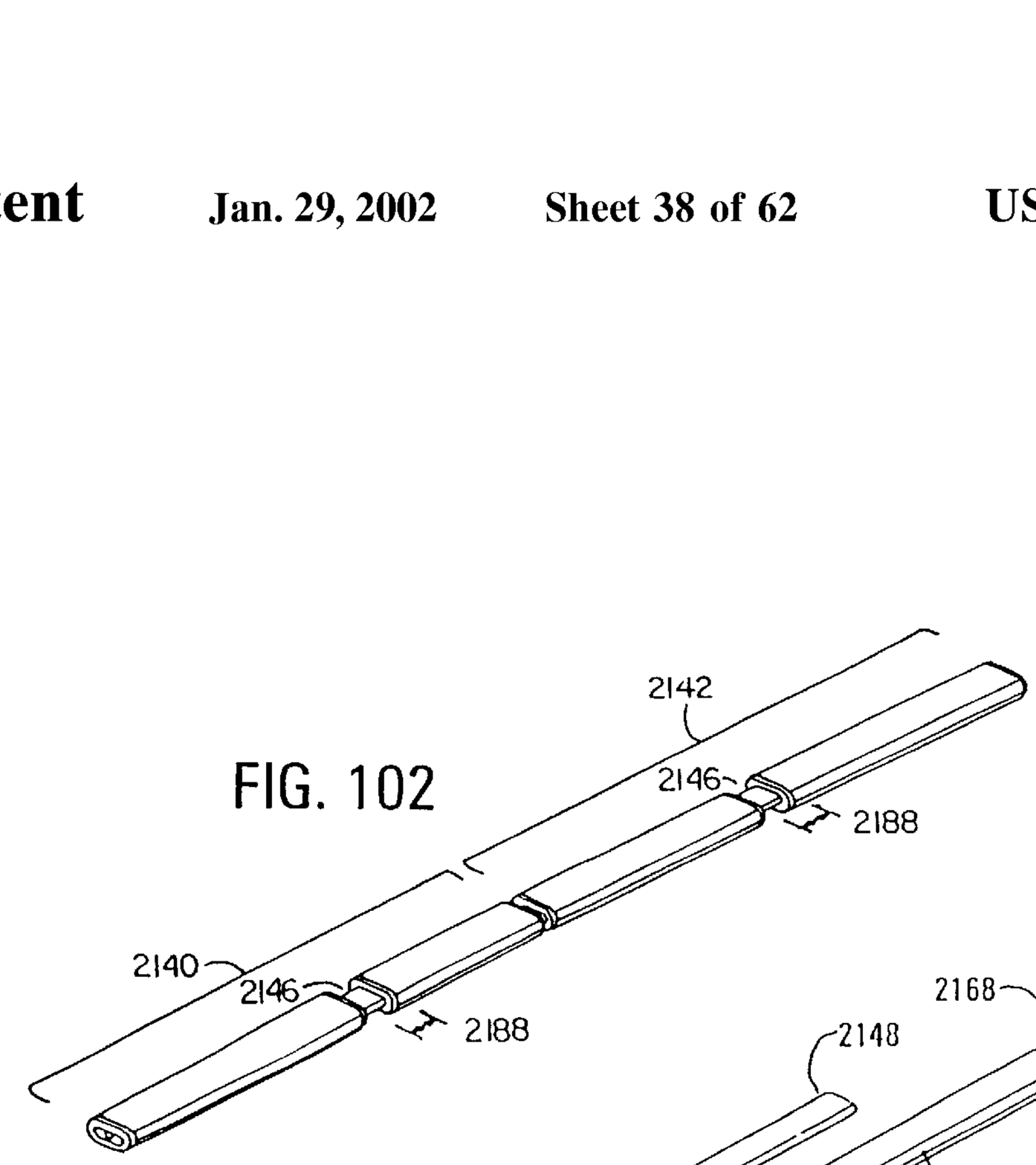


FIG. 103

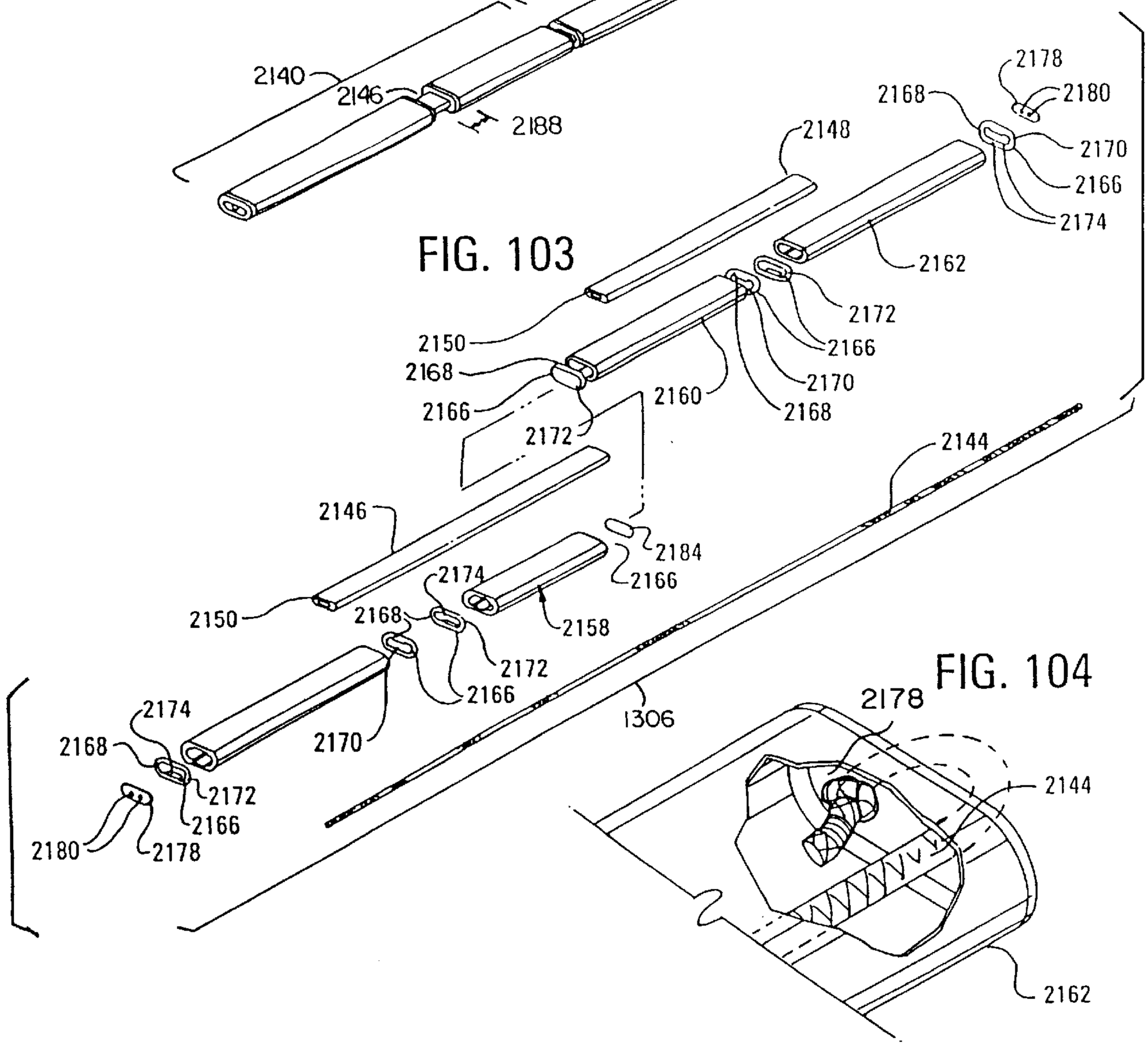


FIG. 104

FIG. 105

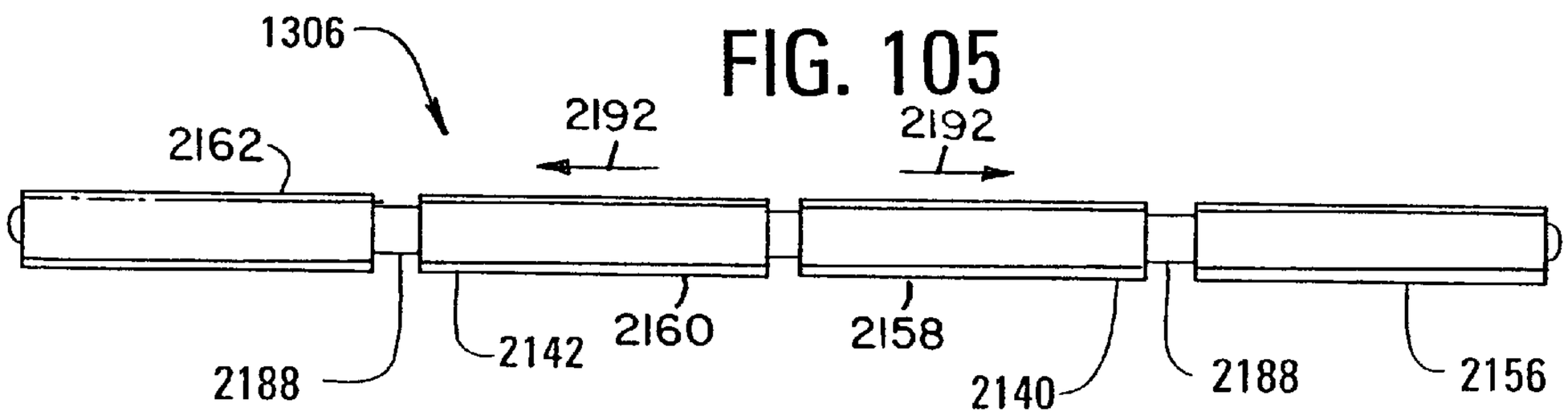


FIG.106

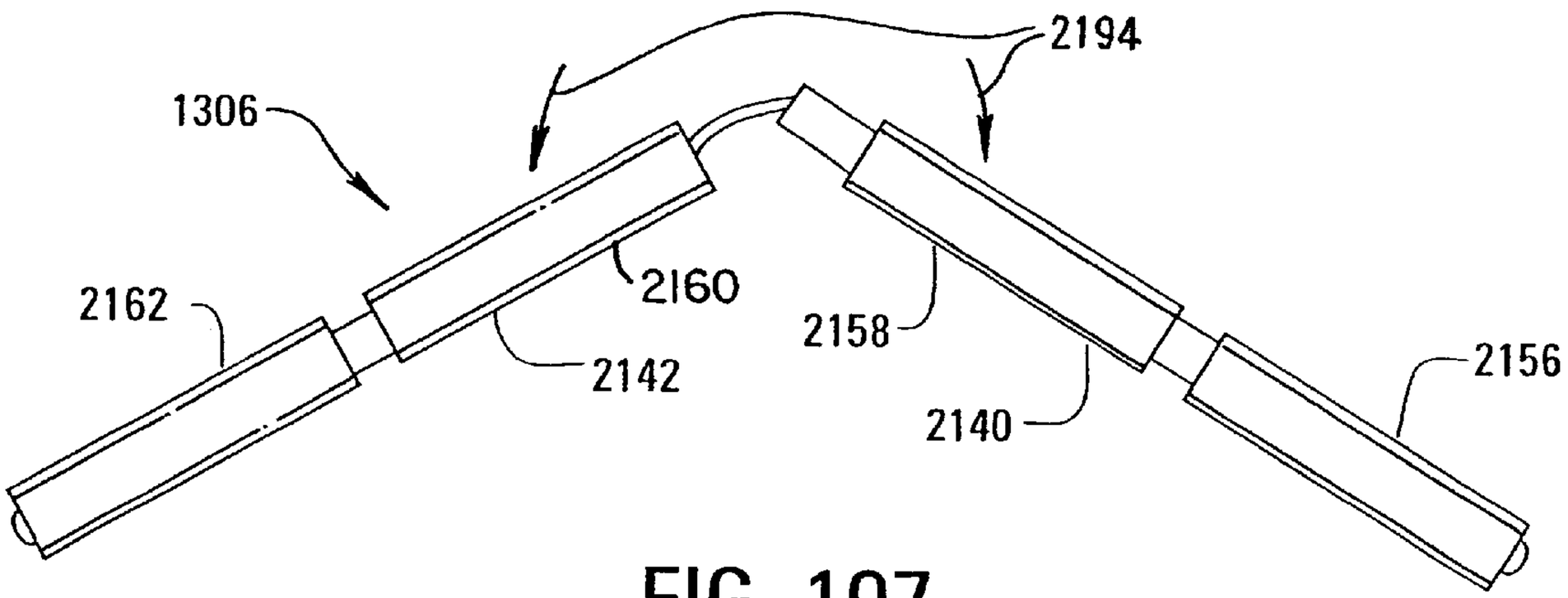


FIG. 107

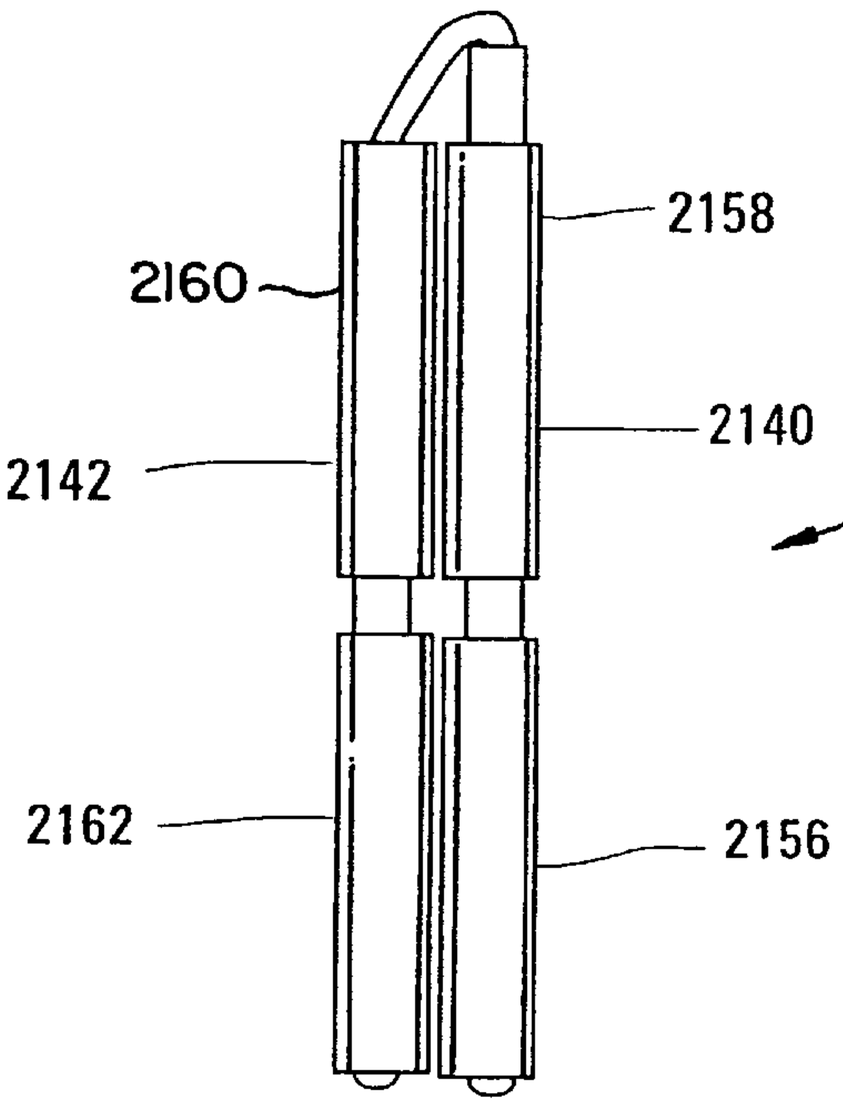


FIG. 108

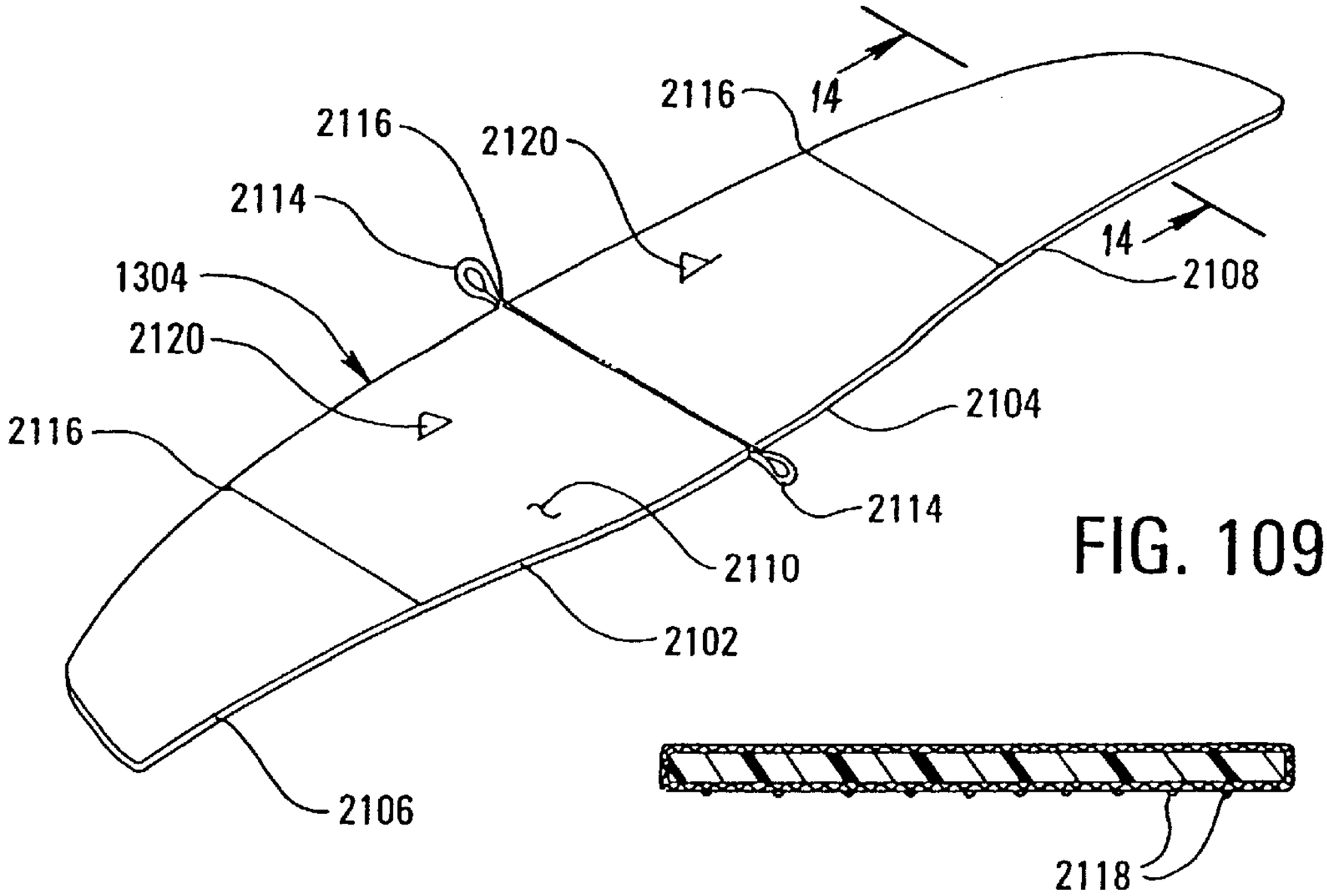


FIG. 109

FIG. 110

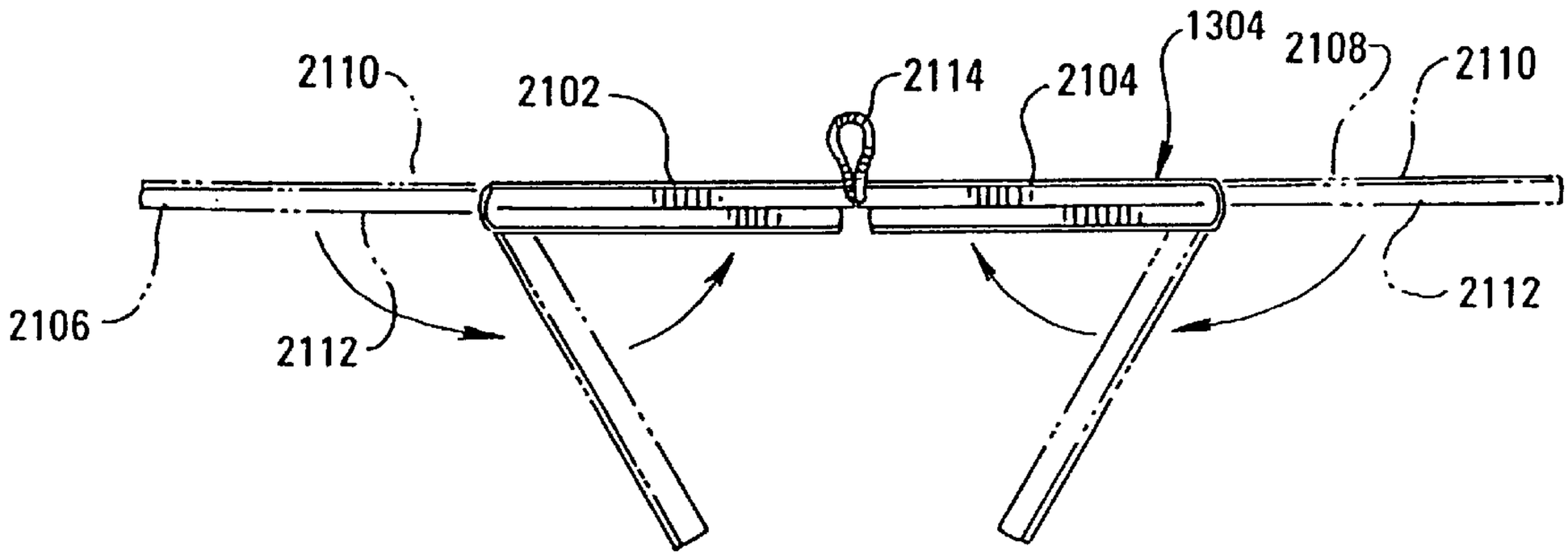


FIG. 111

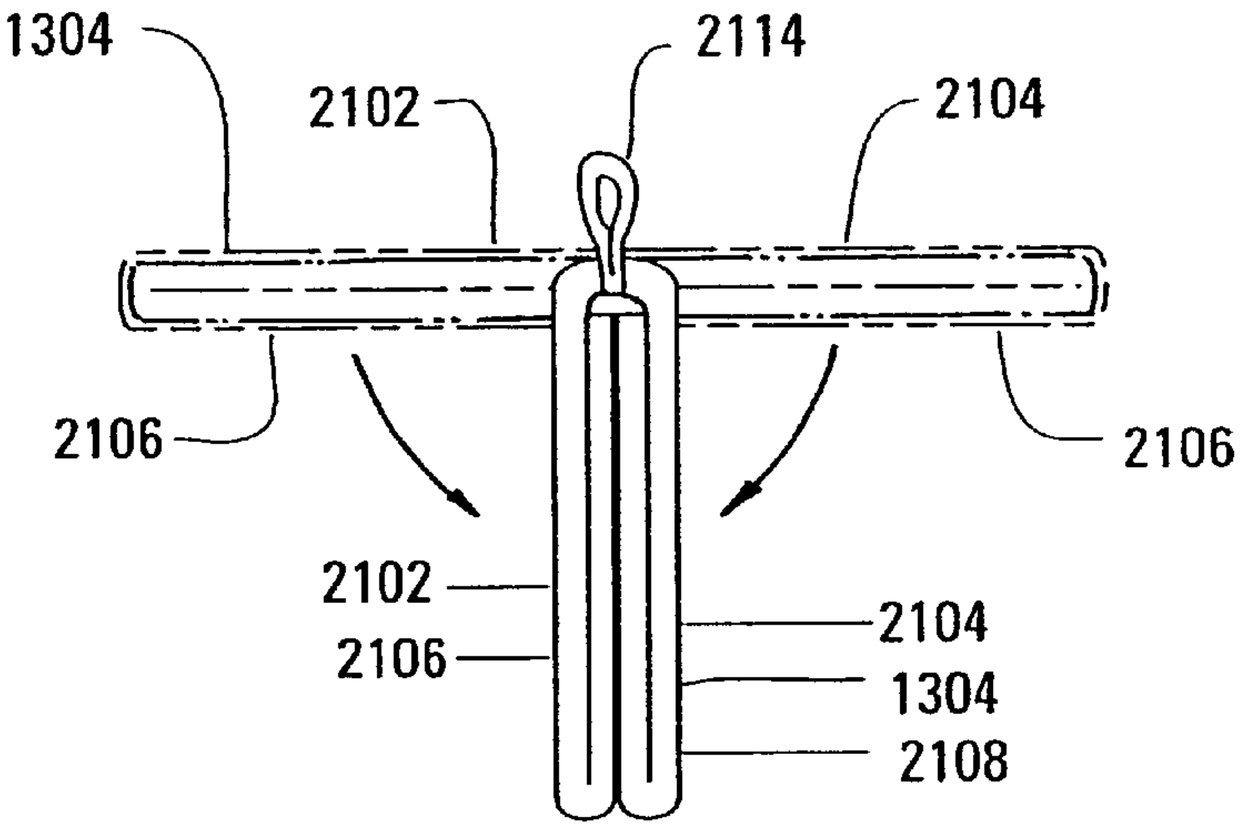


FIG. 112

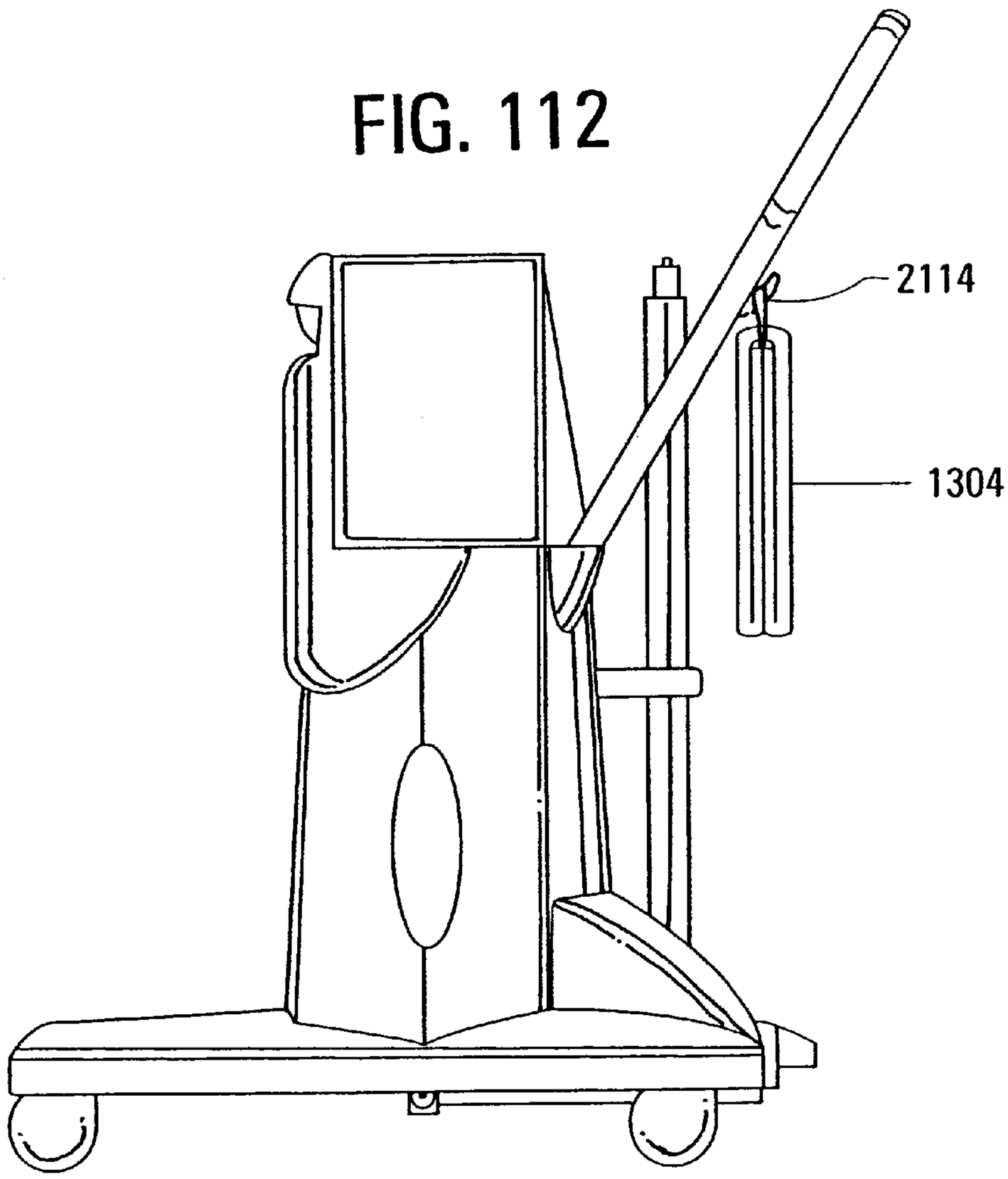


FIG. 113

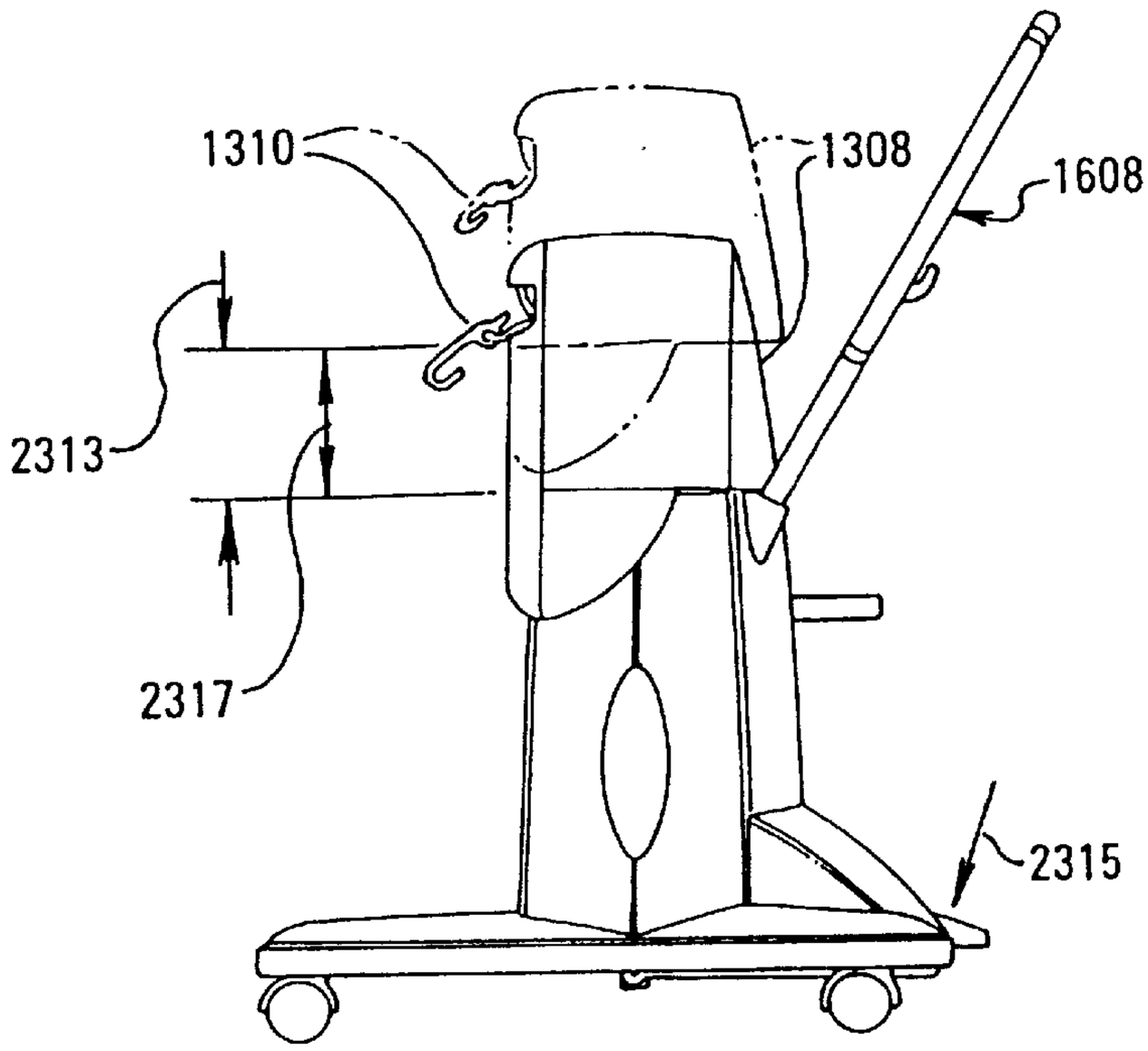


FIG. 114

FIG. 115

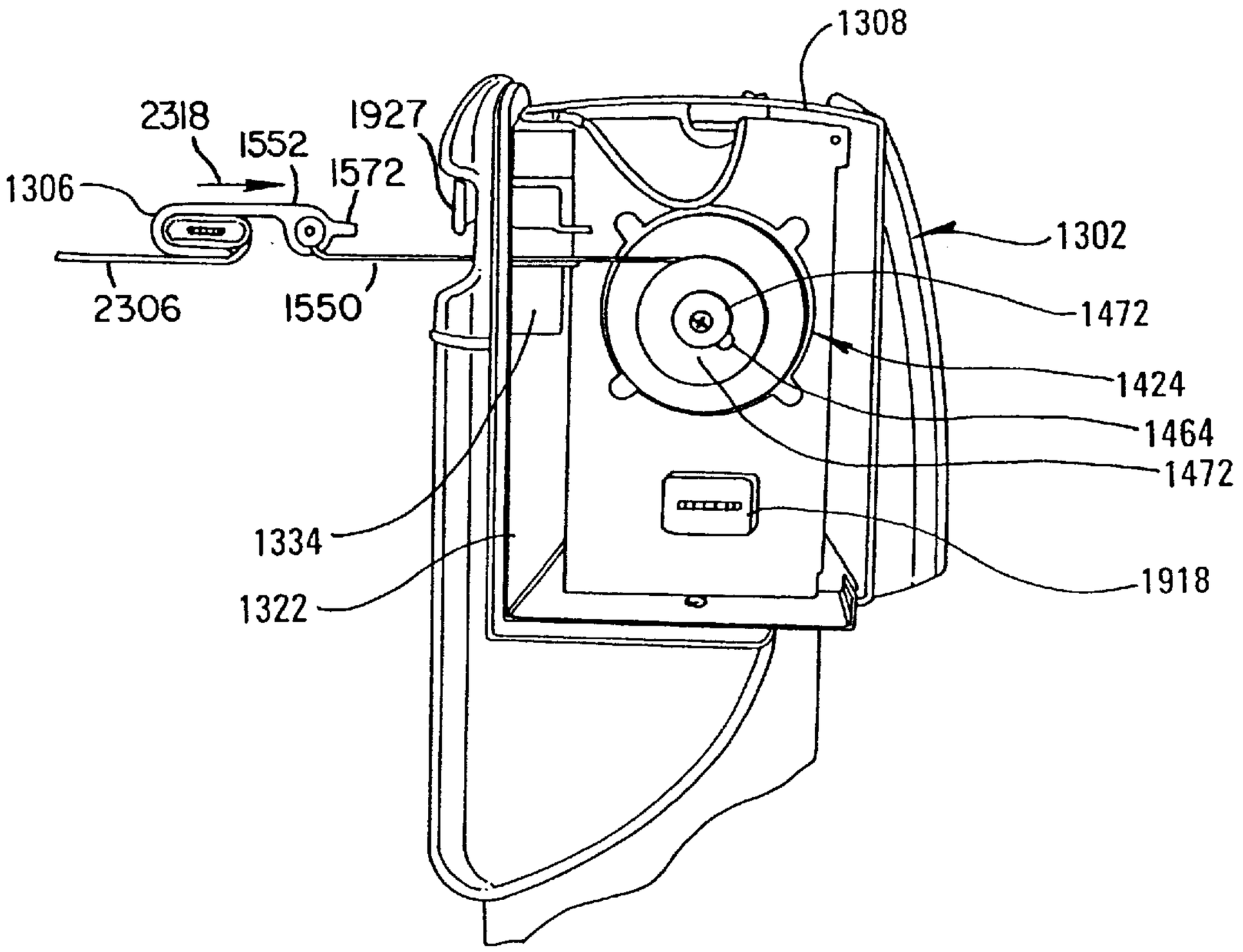


FIG. 116

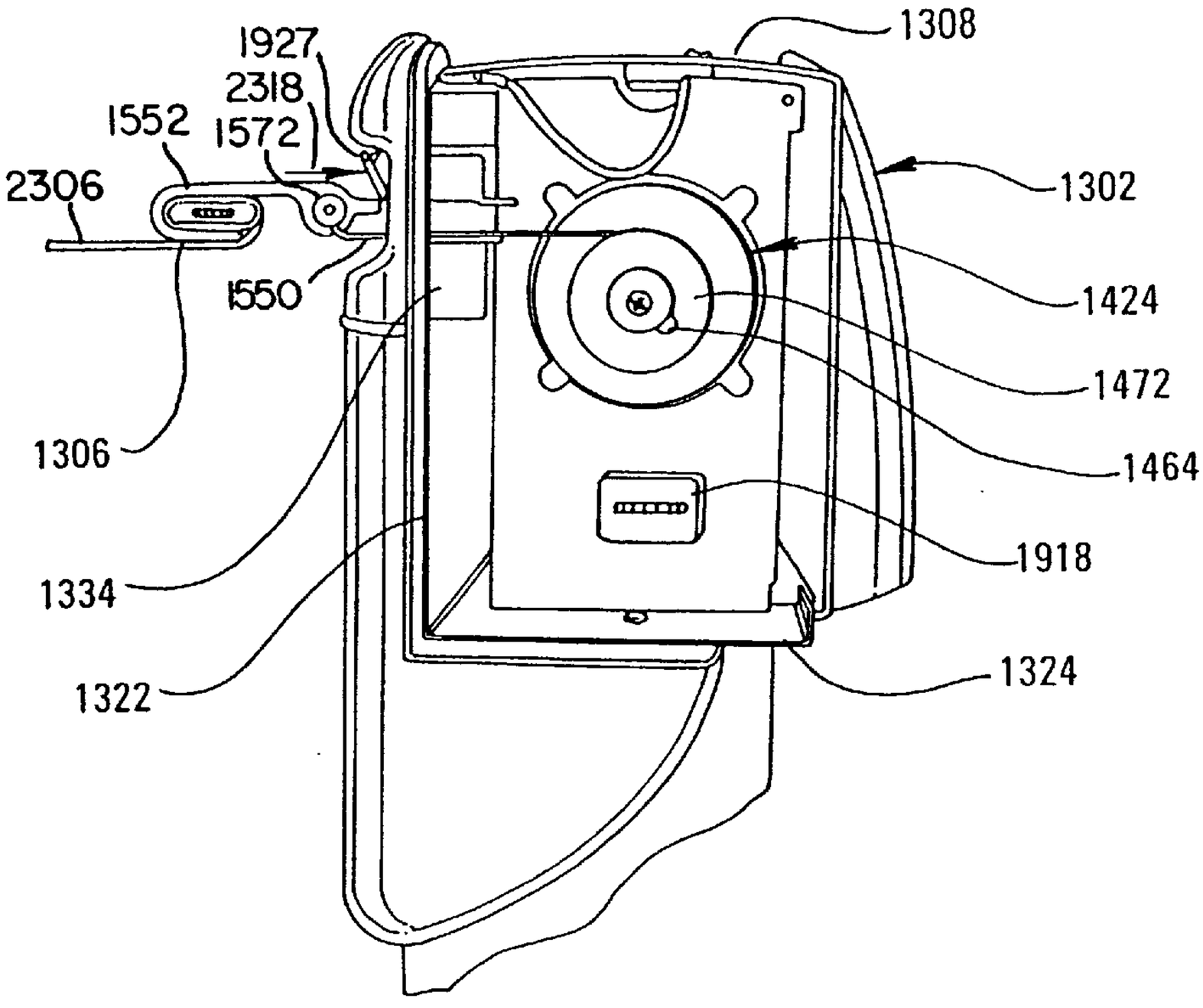


FIG. 117

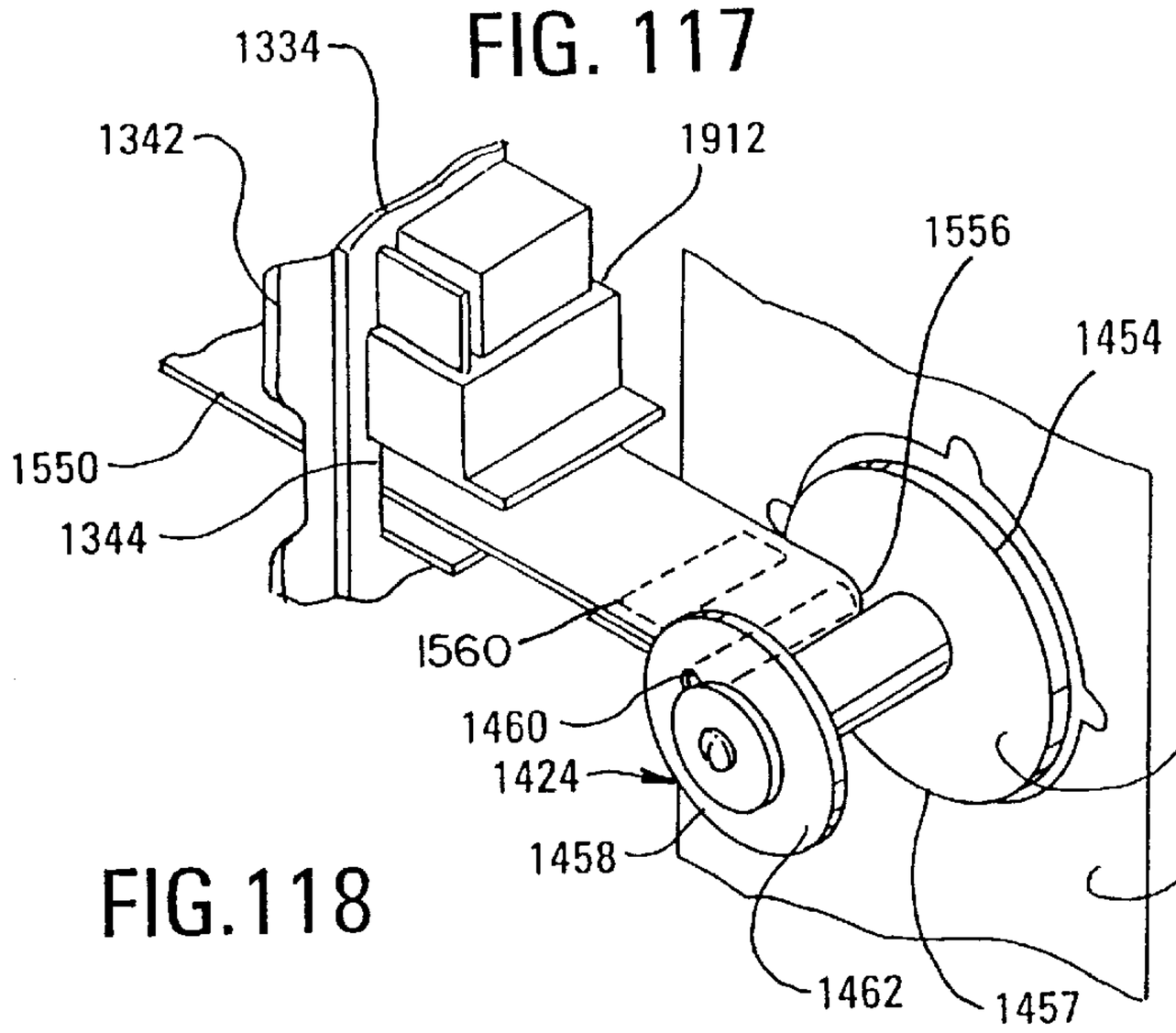


FIG.118

FIG. 119

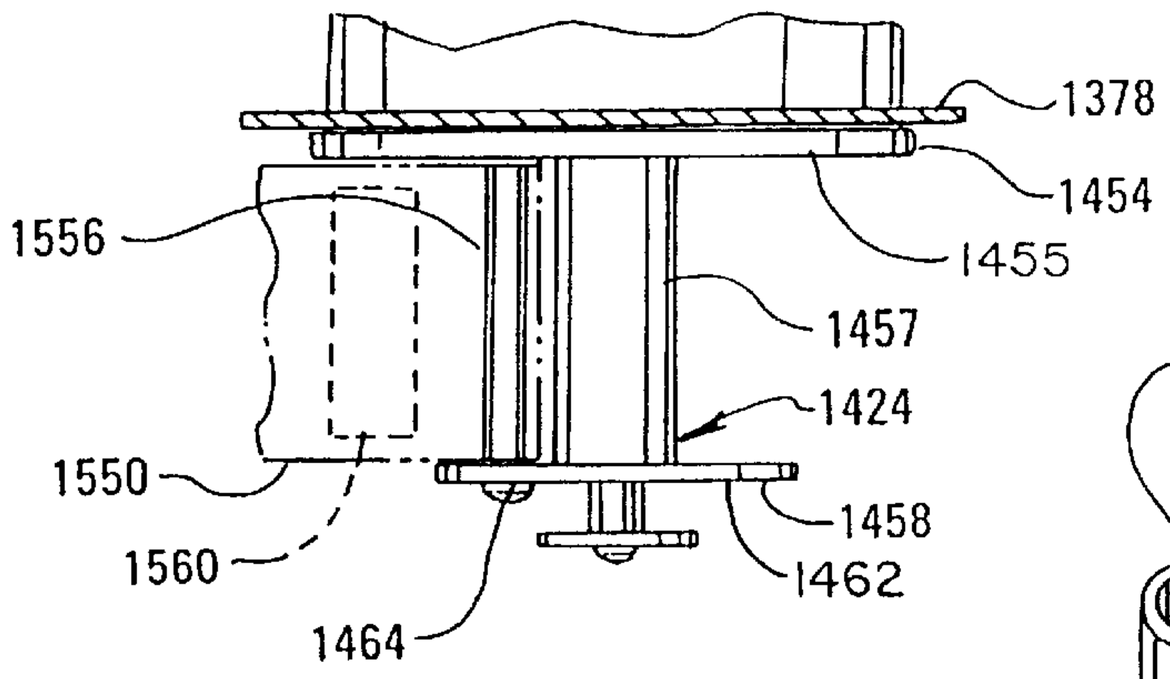
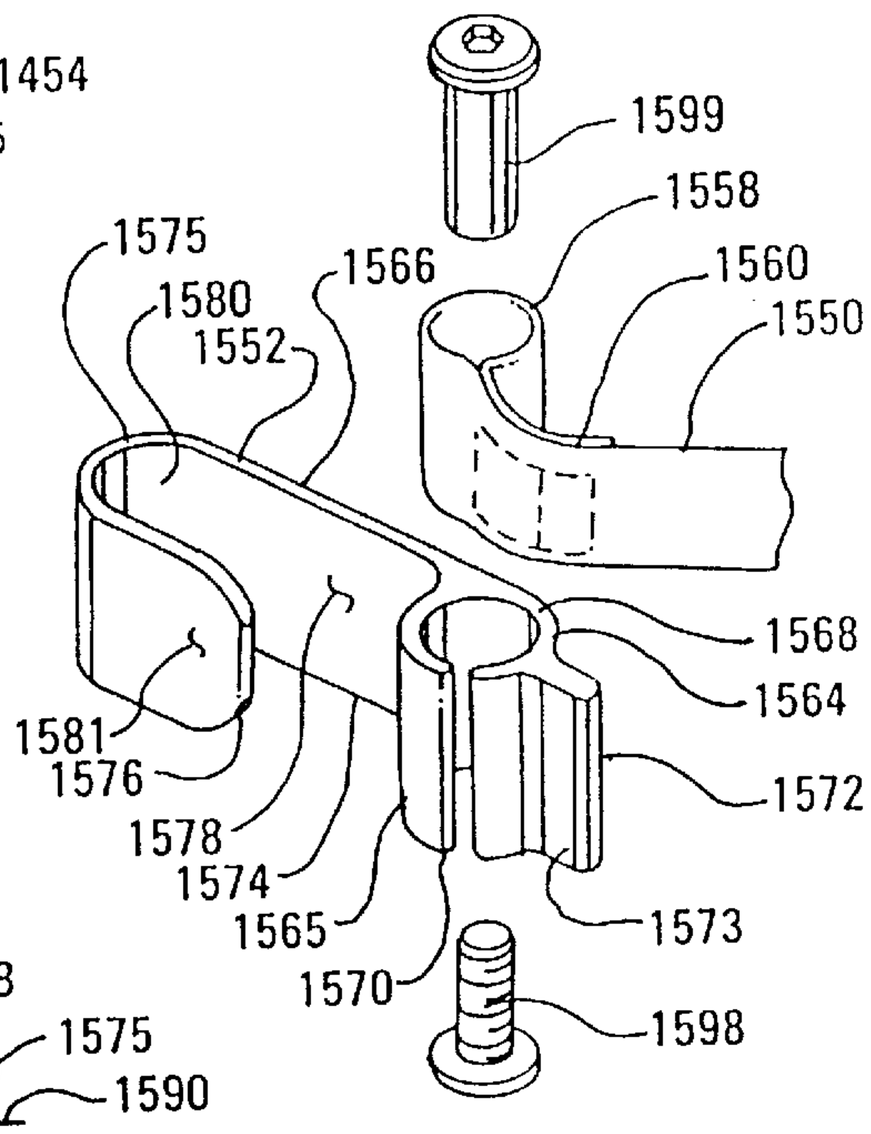


FIG. 120



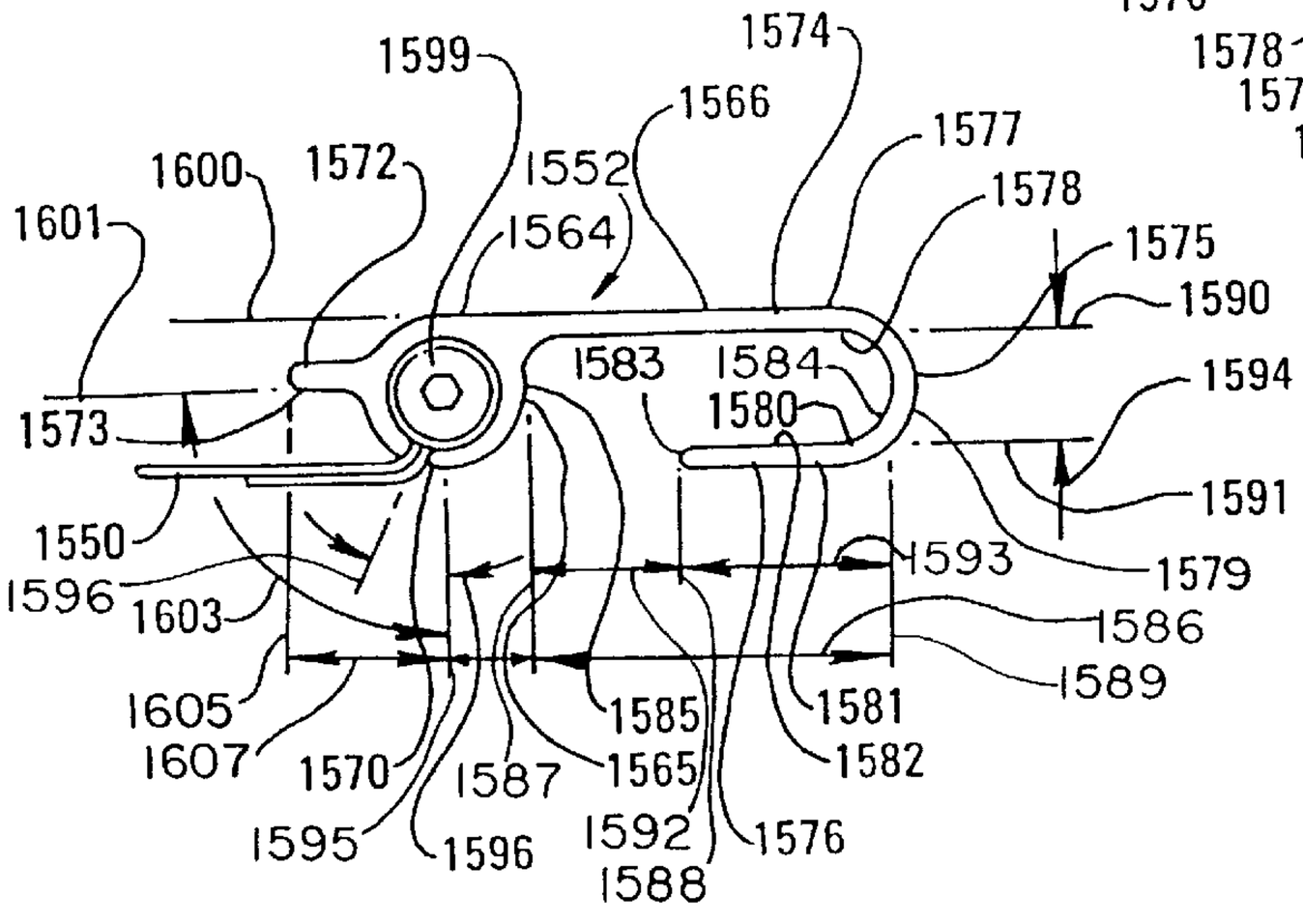


FIG. 121

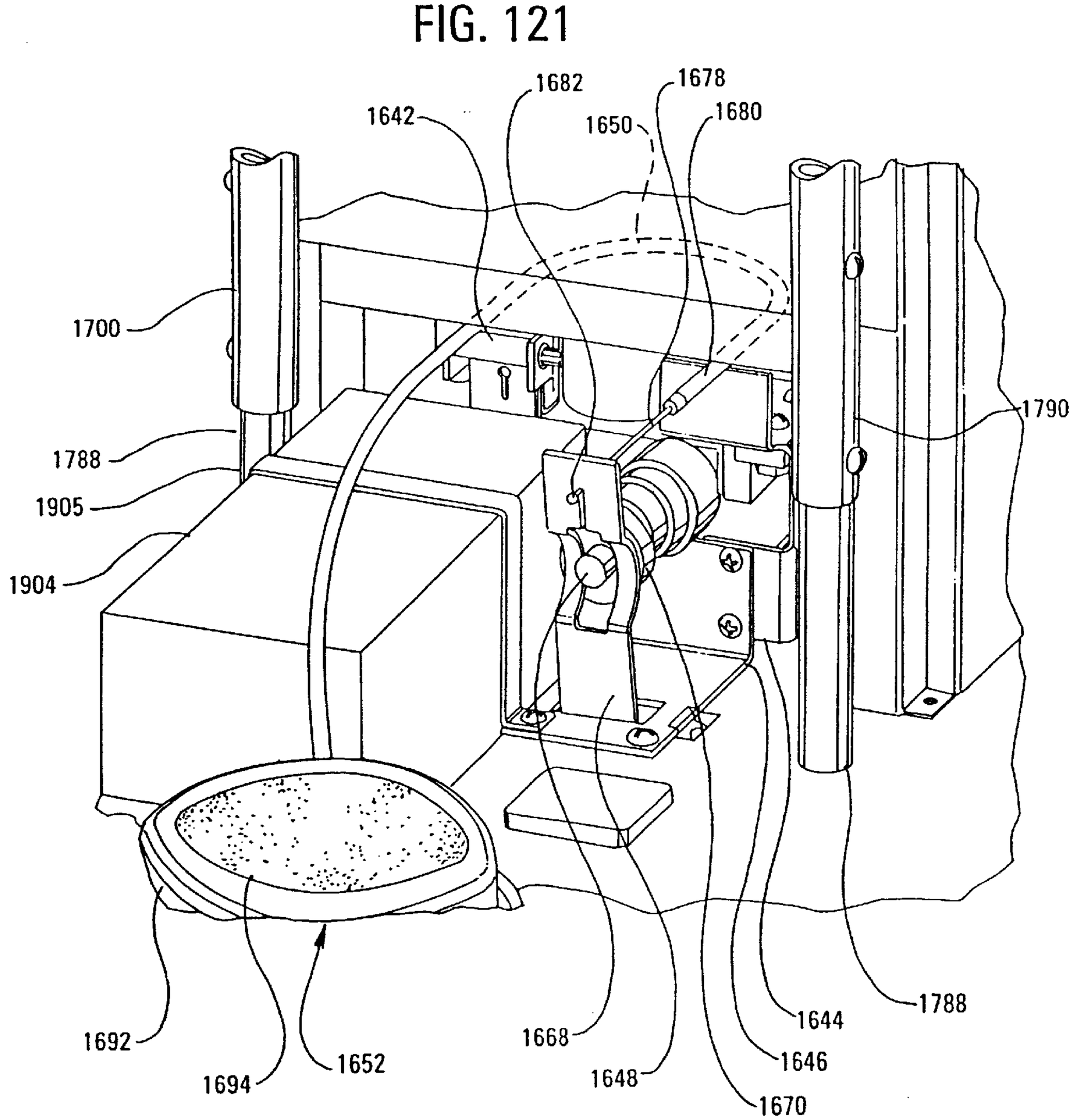

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FIG. 122

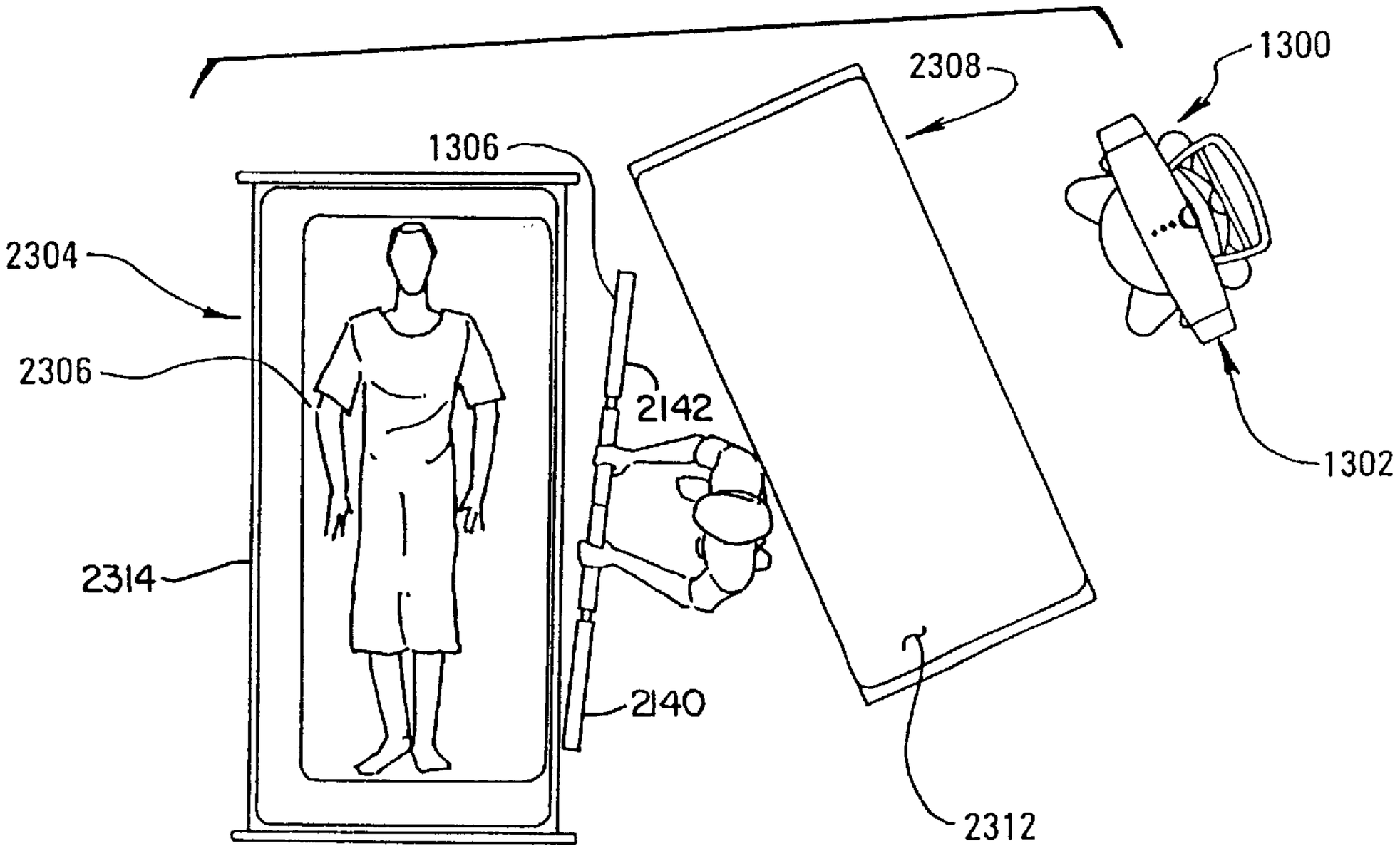

FIG. 123

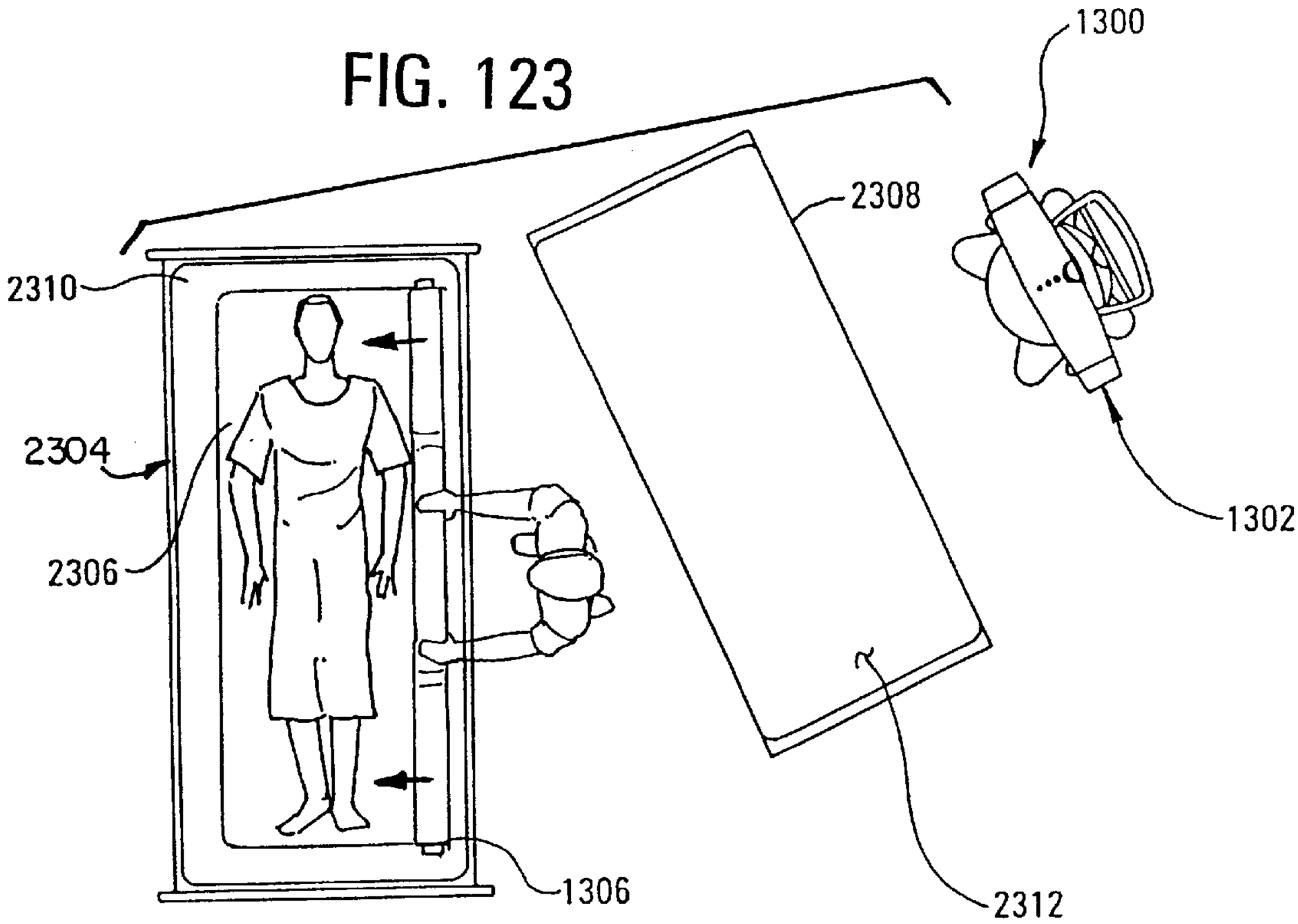

FIG. 124

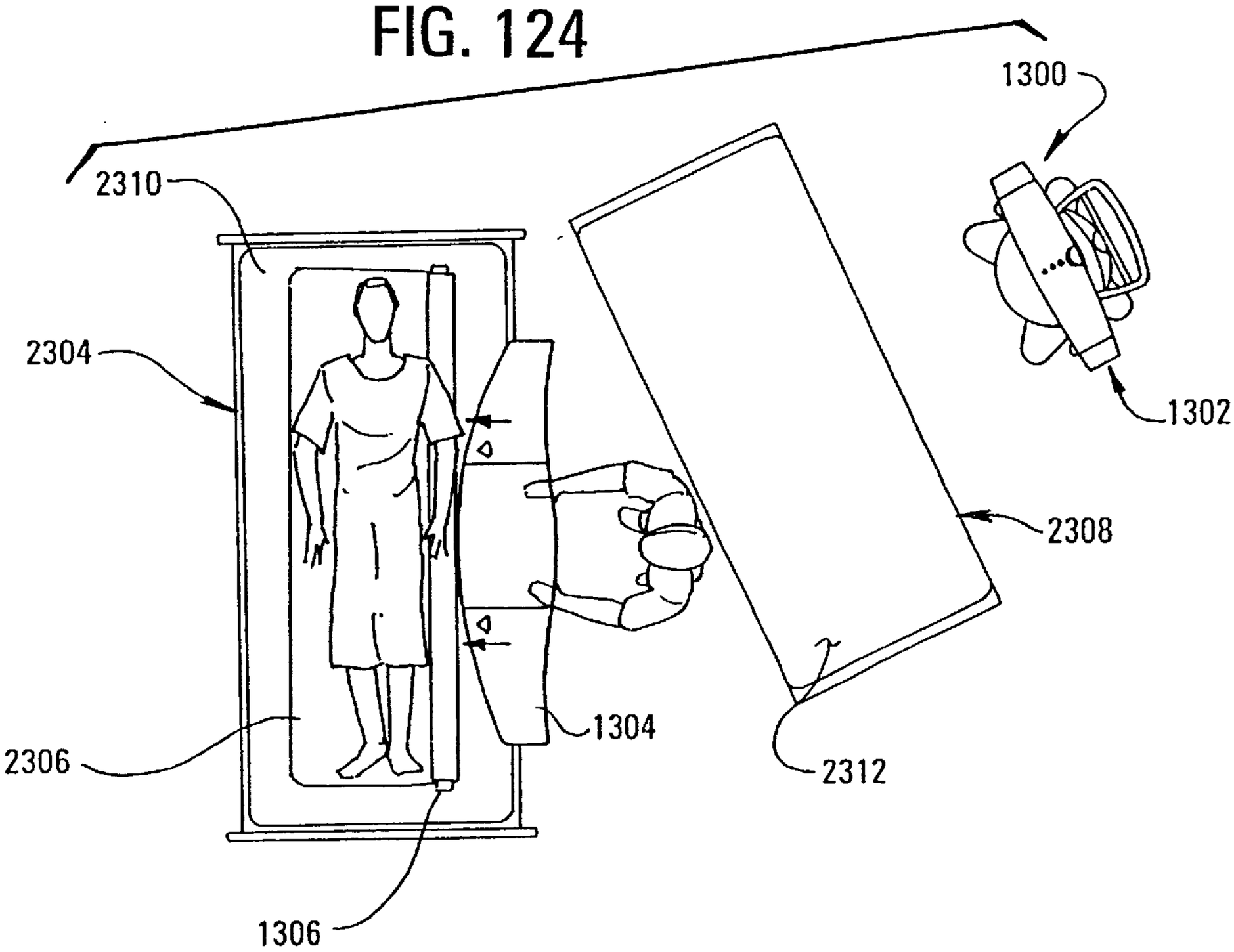

FIG. 125

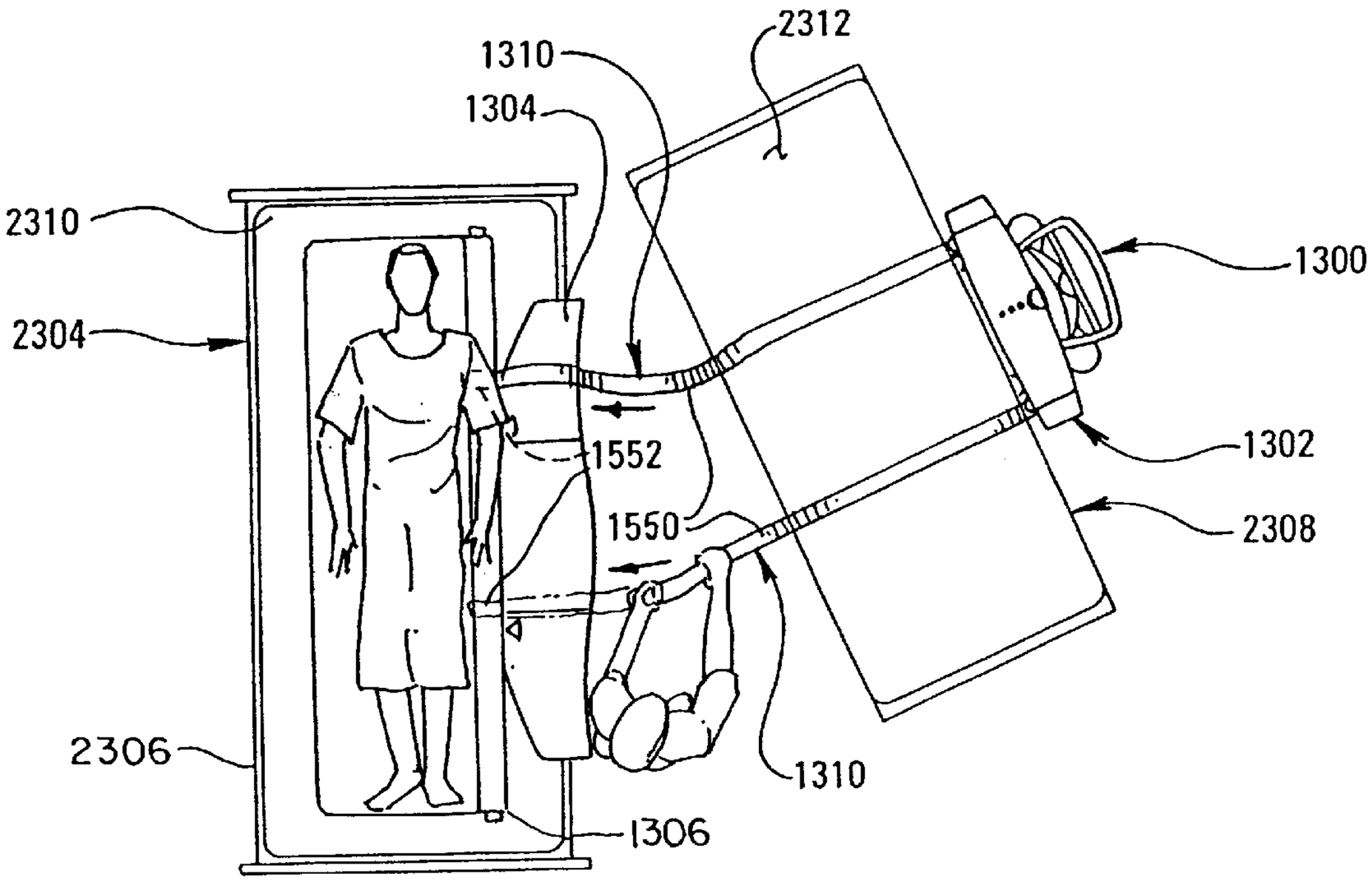

FIG. 126

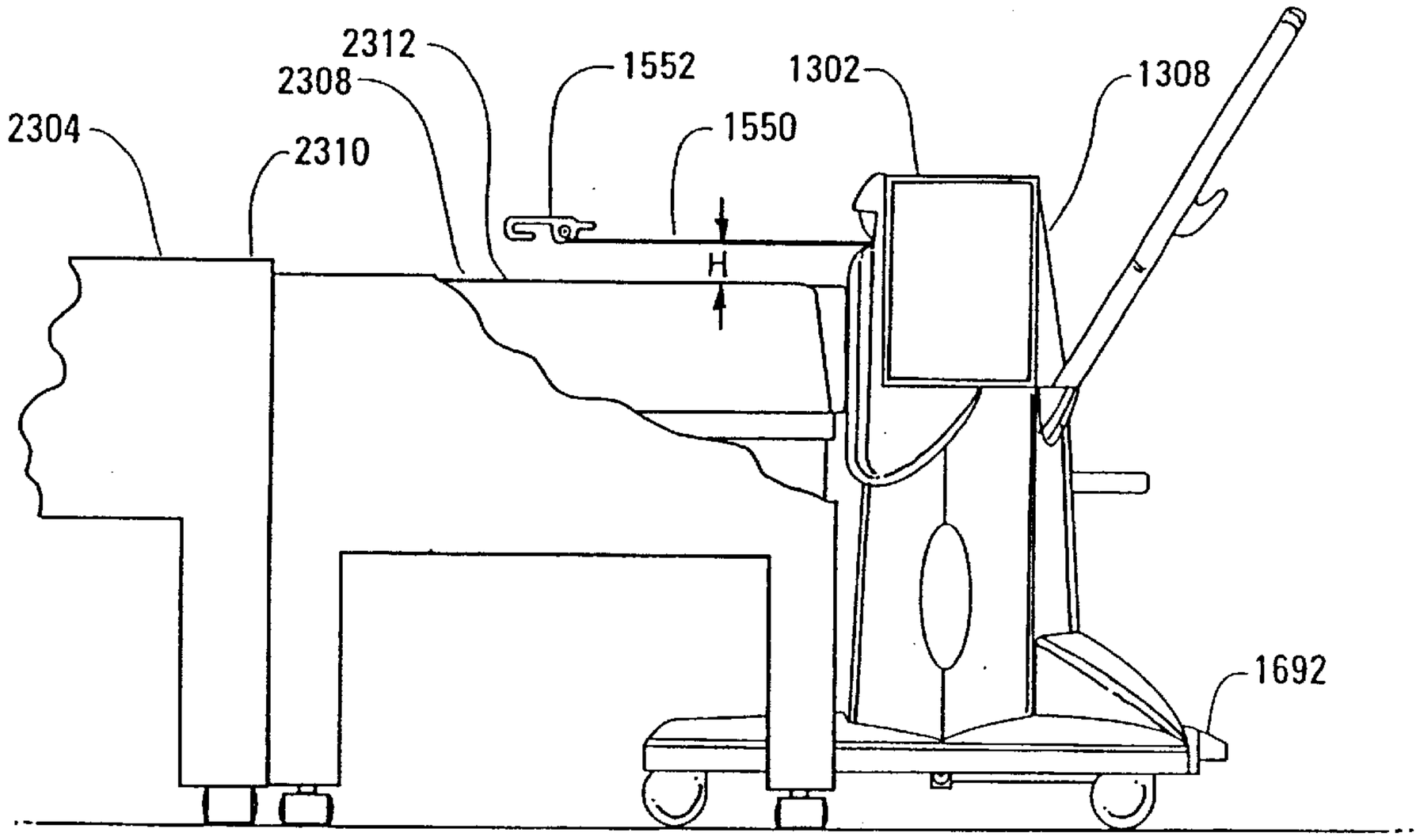

FIG. 128

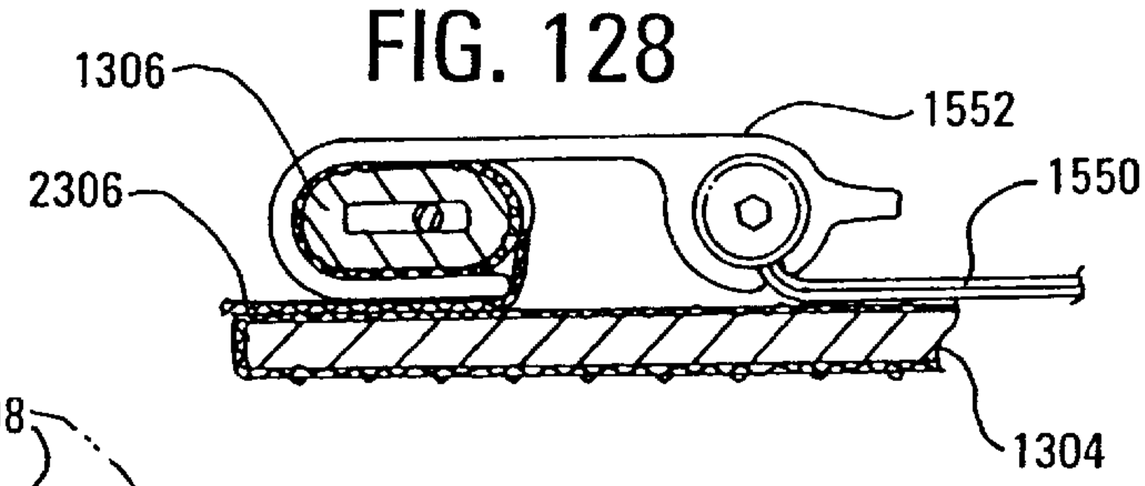

FIG. 127

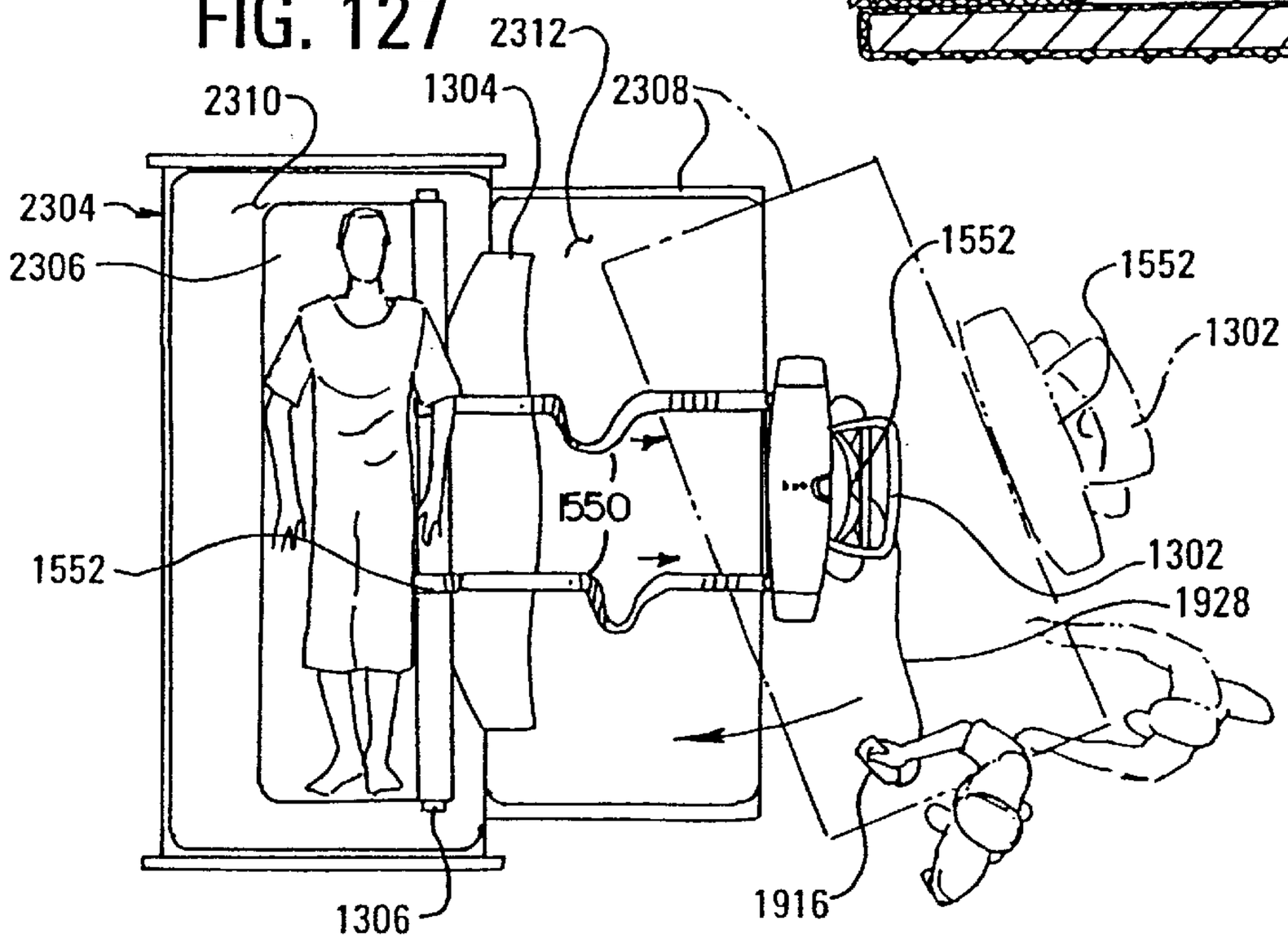

FIG. 129

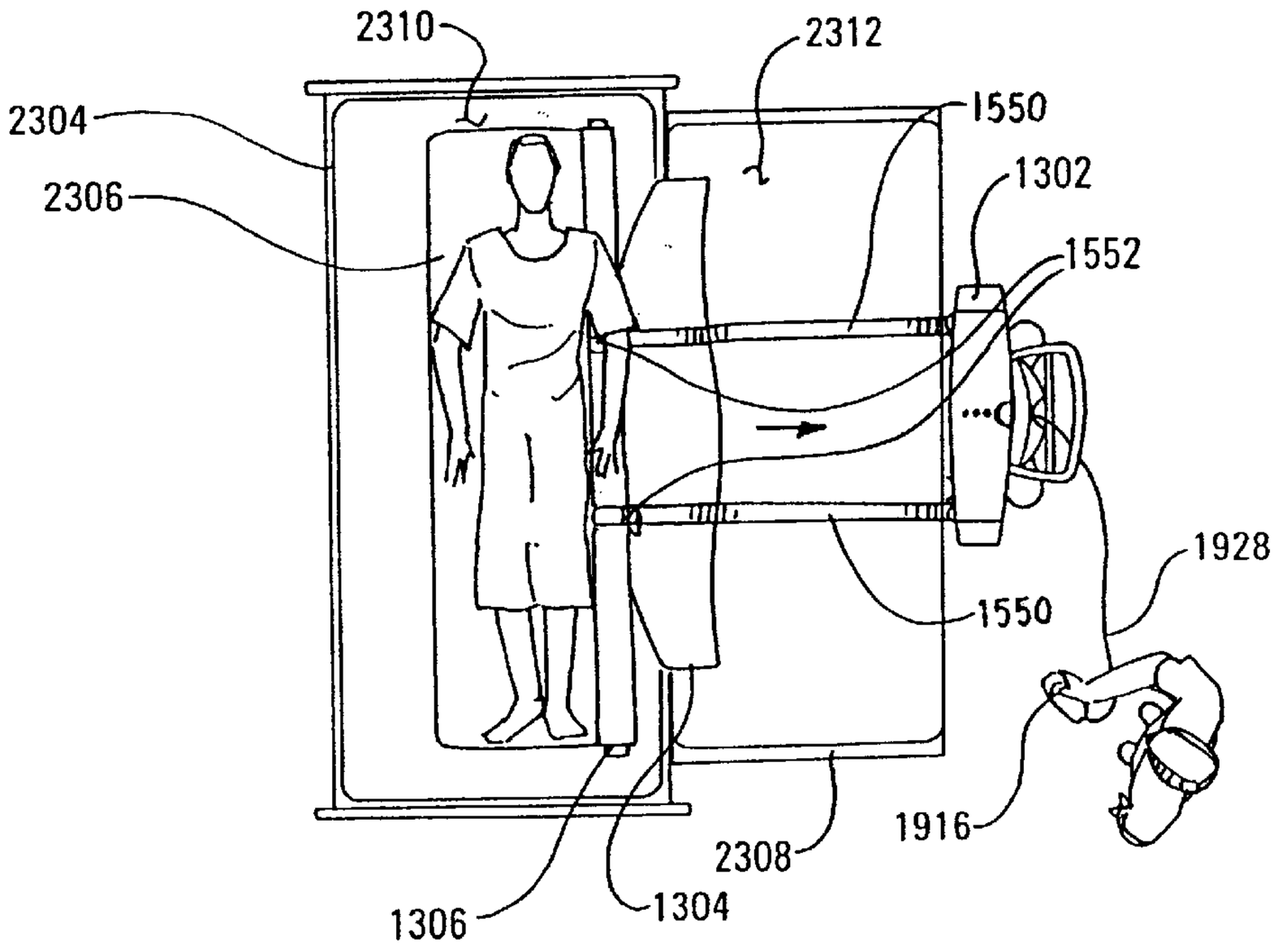

FIG.130

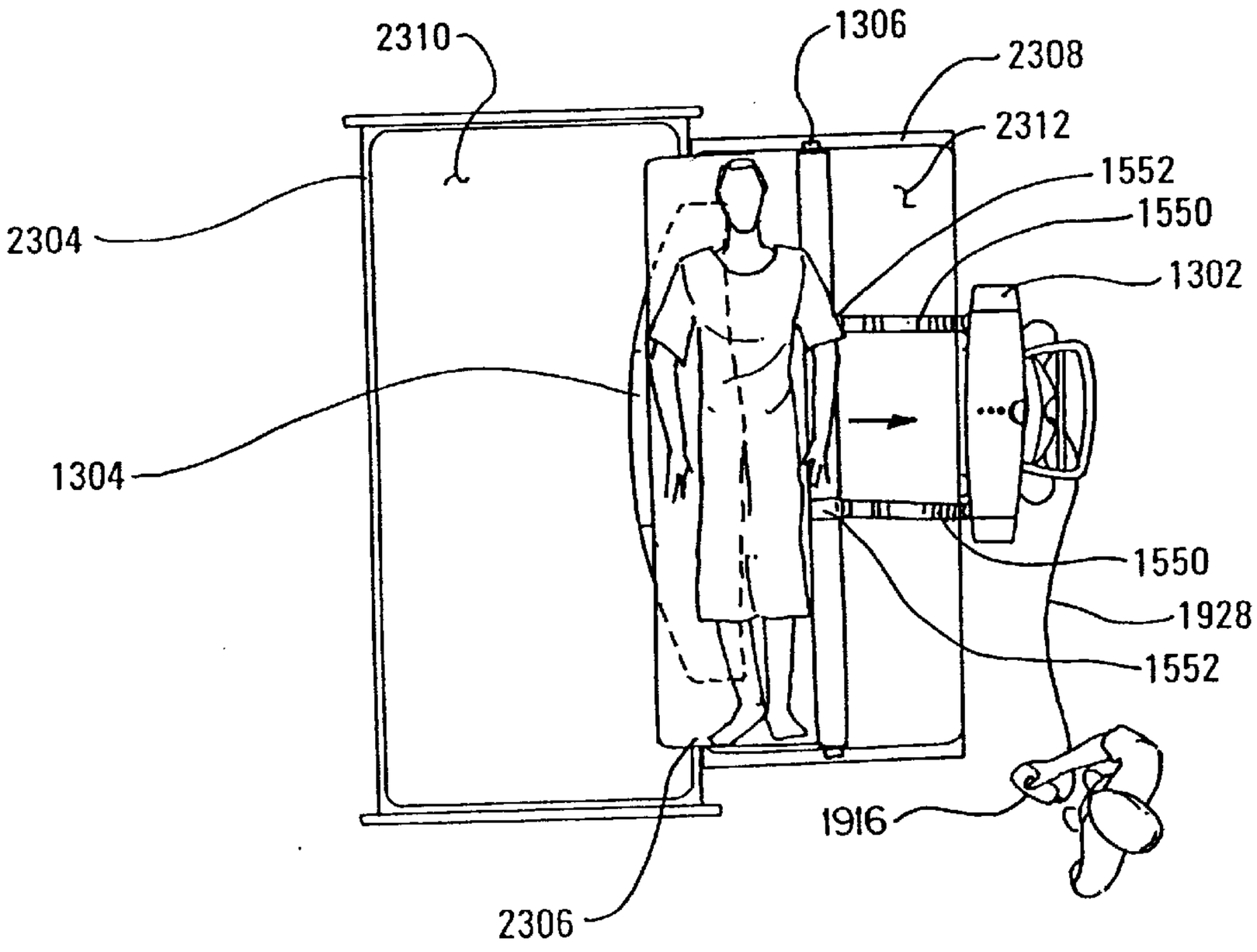

FIG. 131

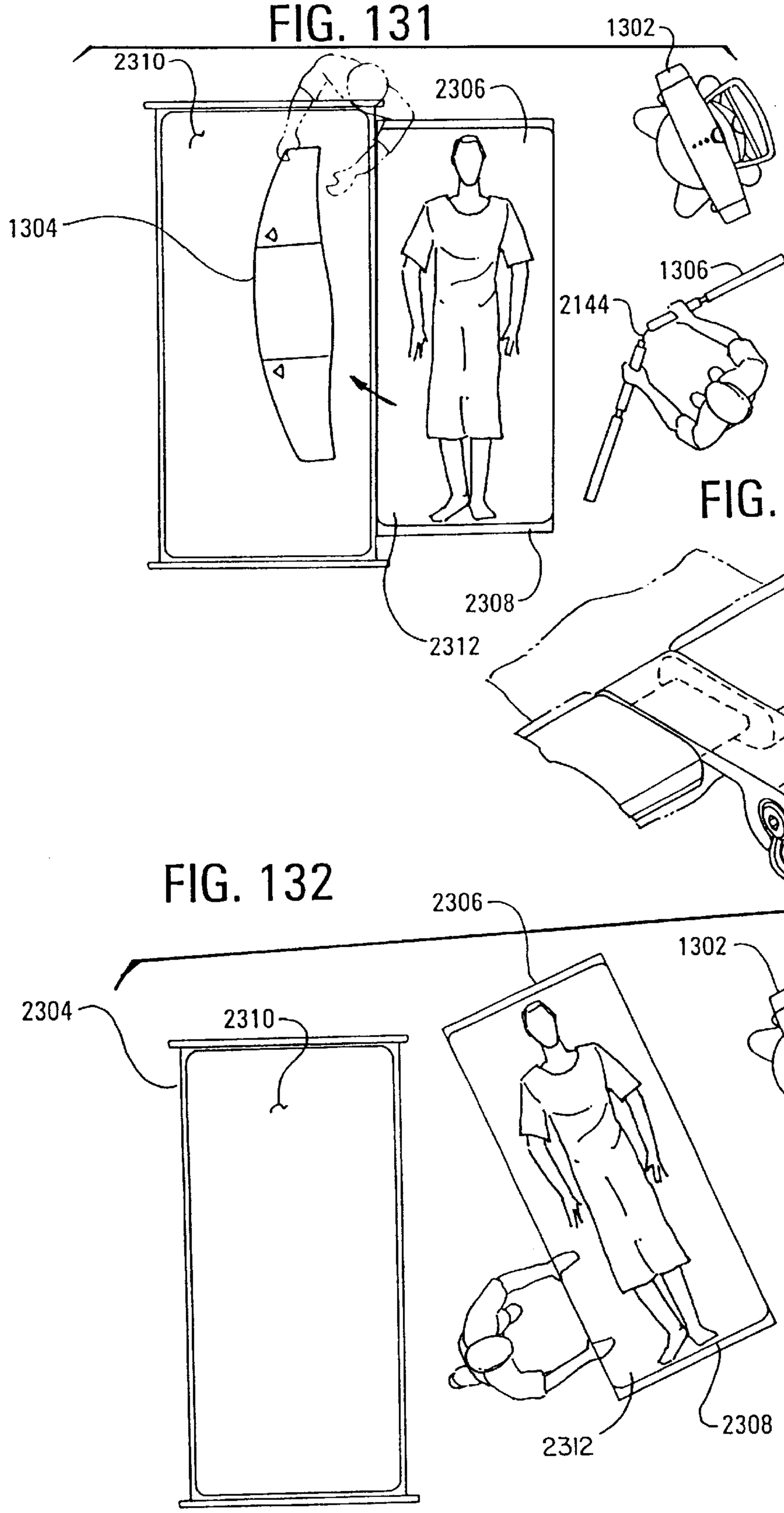

FIG. 133

FIG. 132

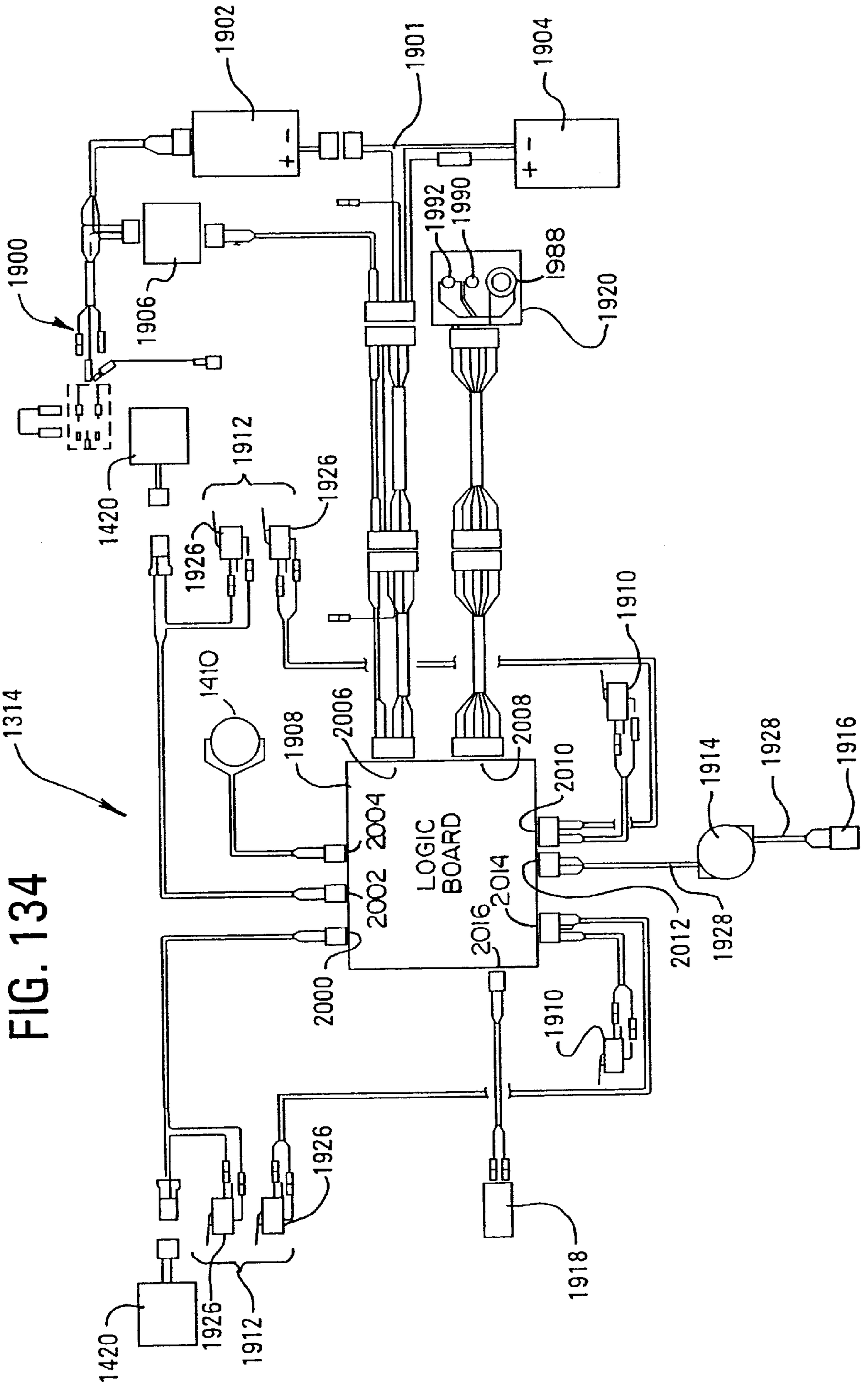
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FIG. 134

FIG. 135

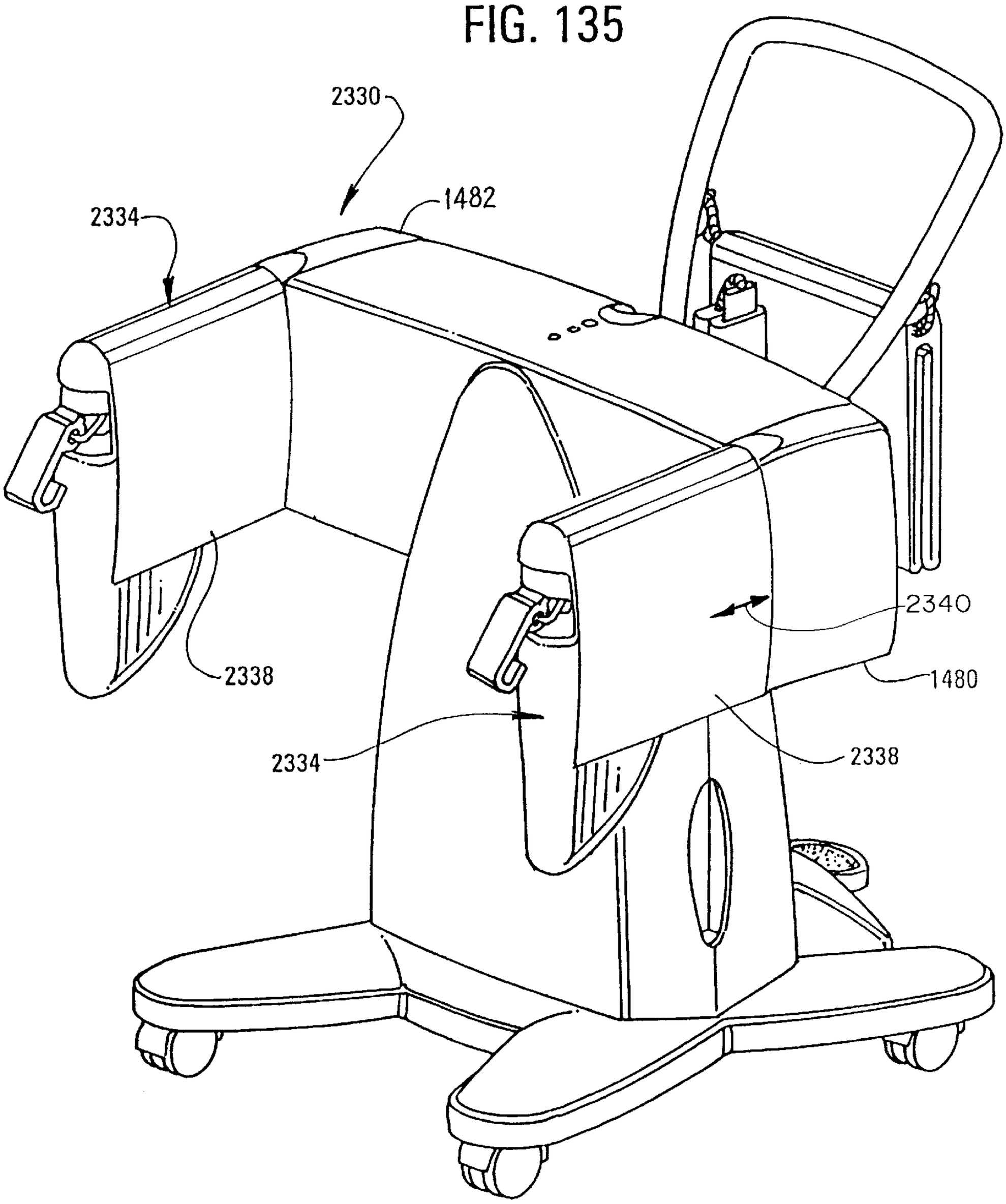


FIG. 136

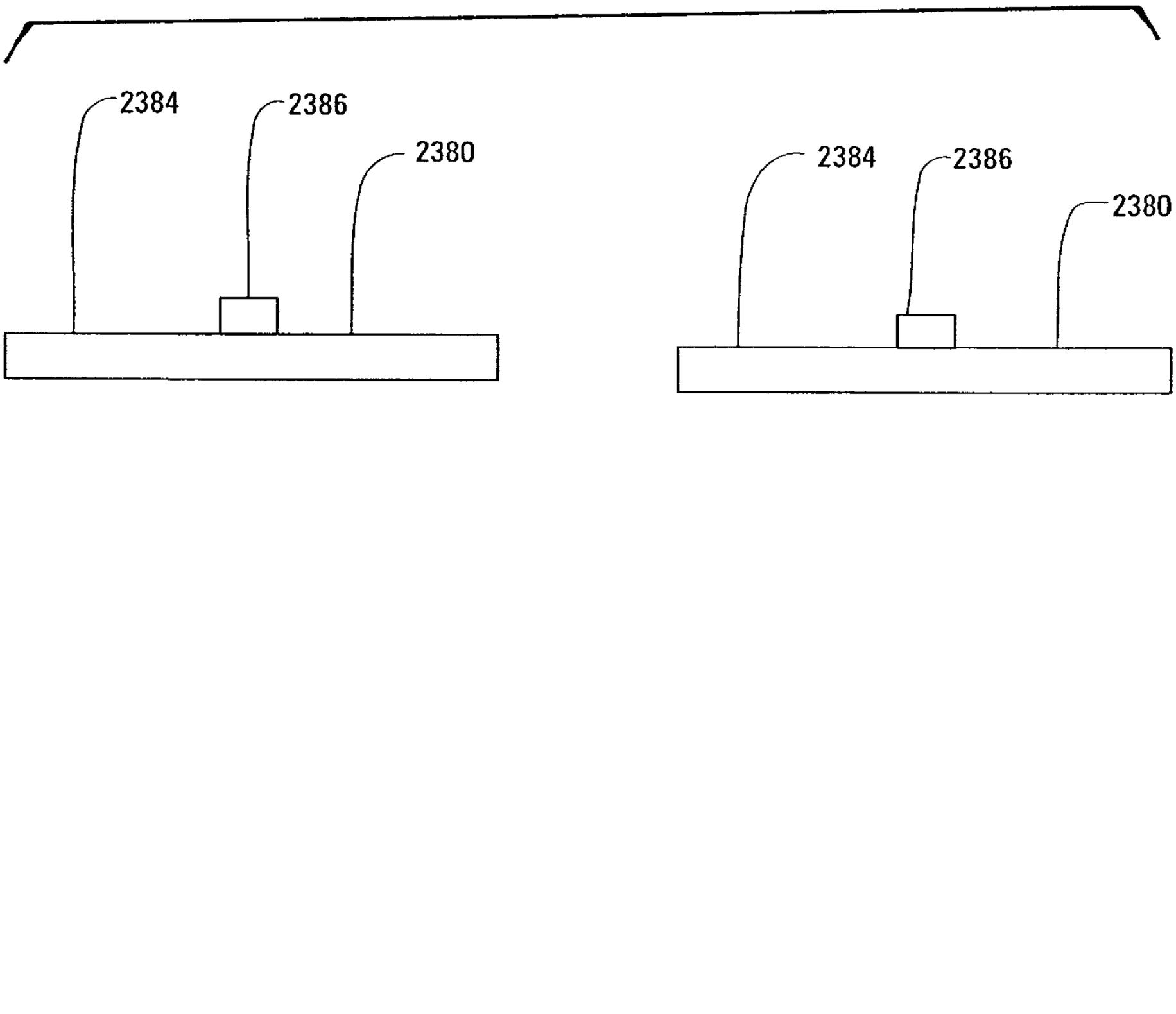


Fig. 137

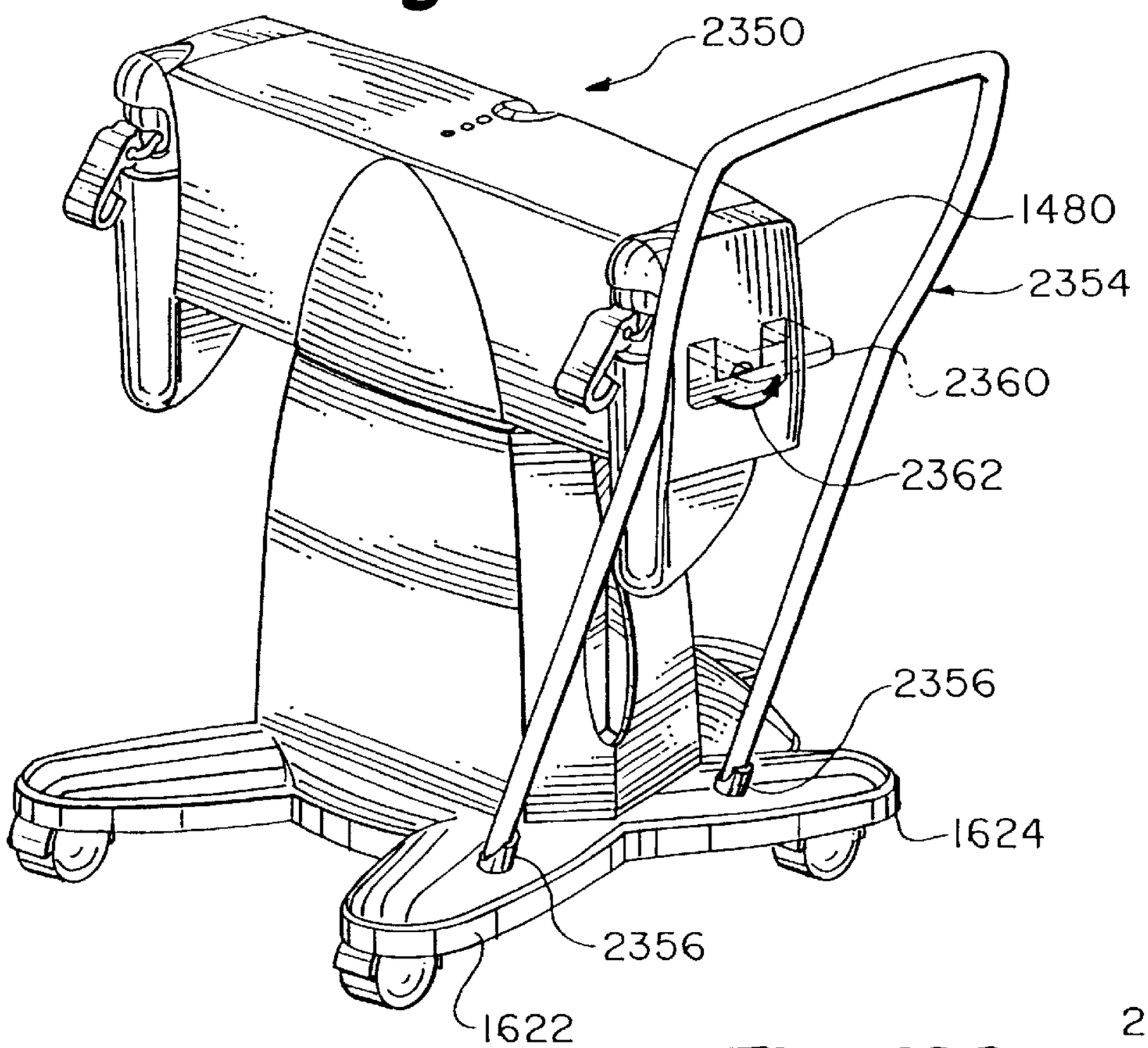


Fig. 138

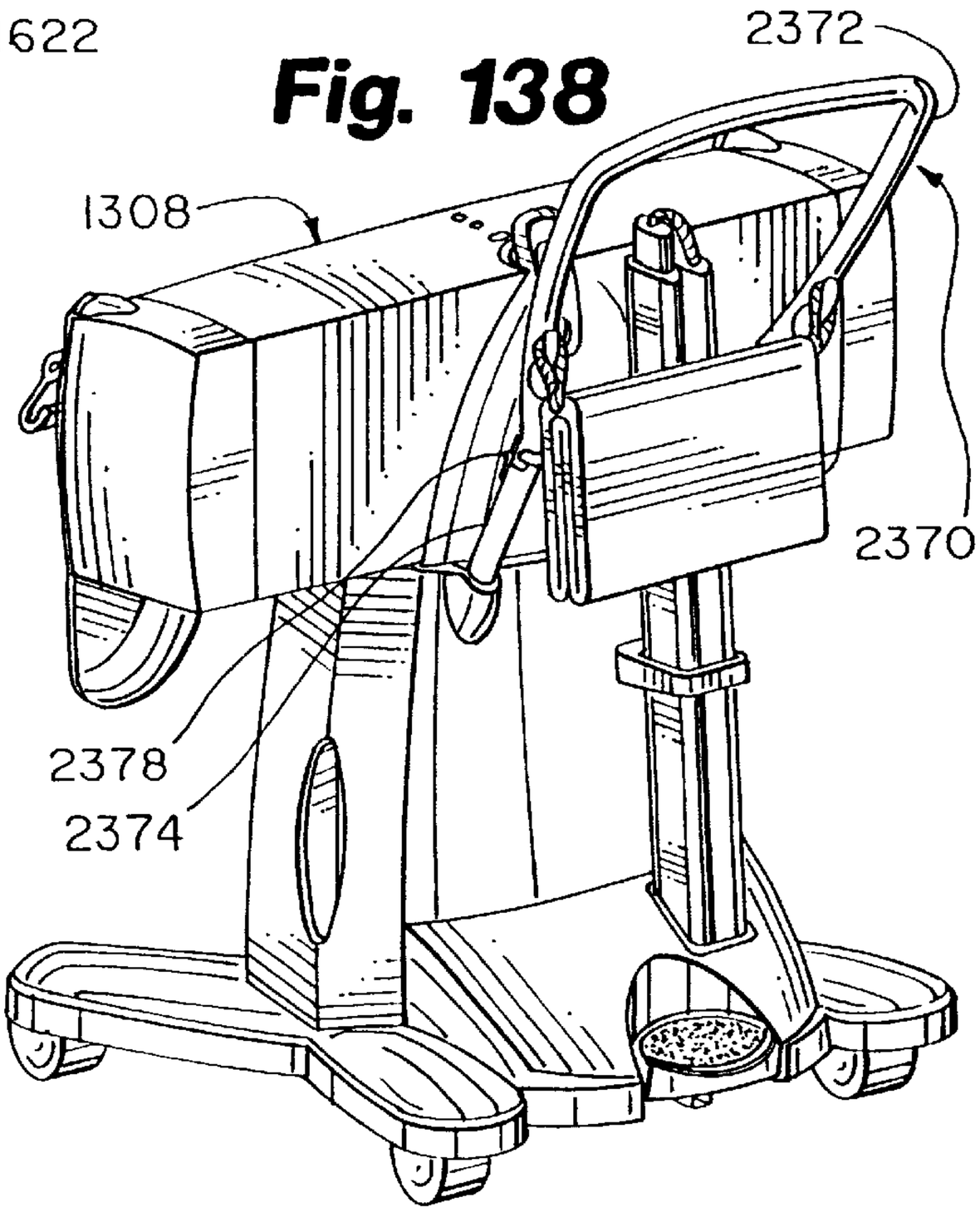


Fig. 139

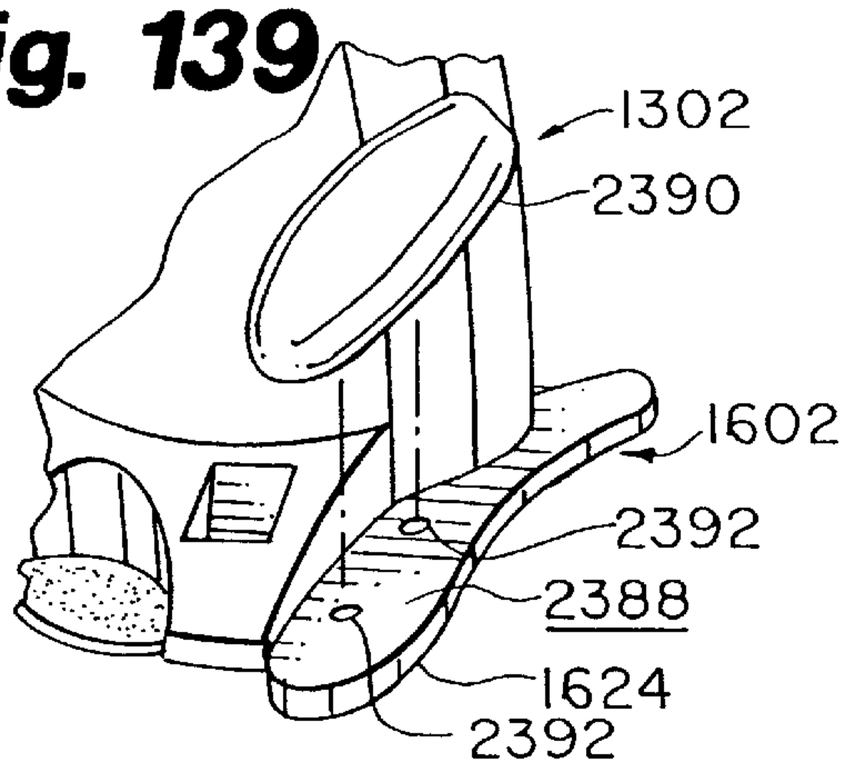


Fig. 140

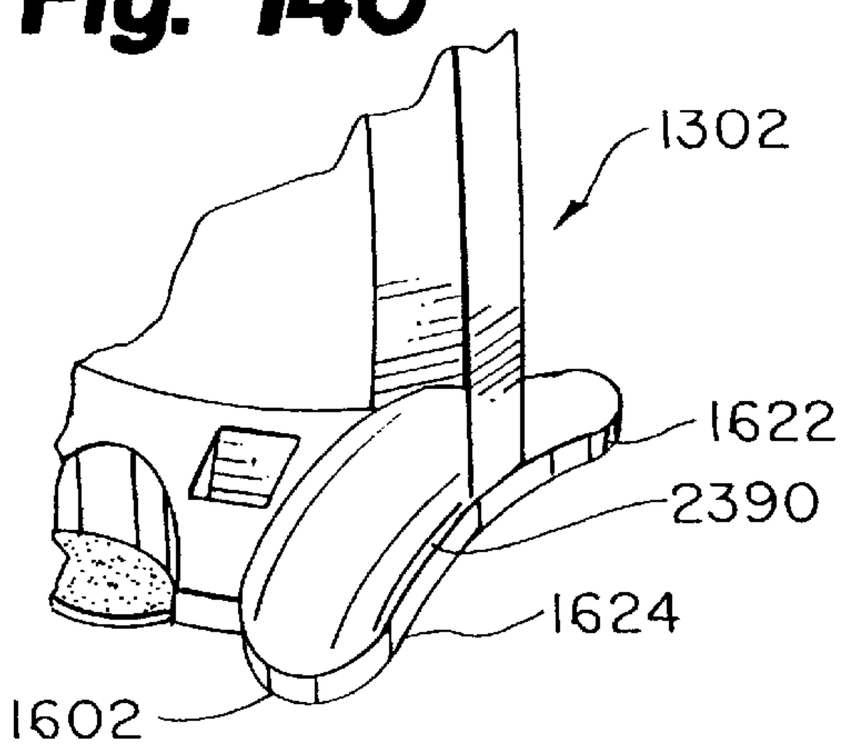


Fig. 141

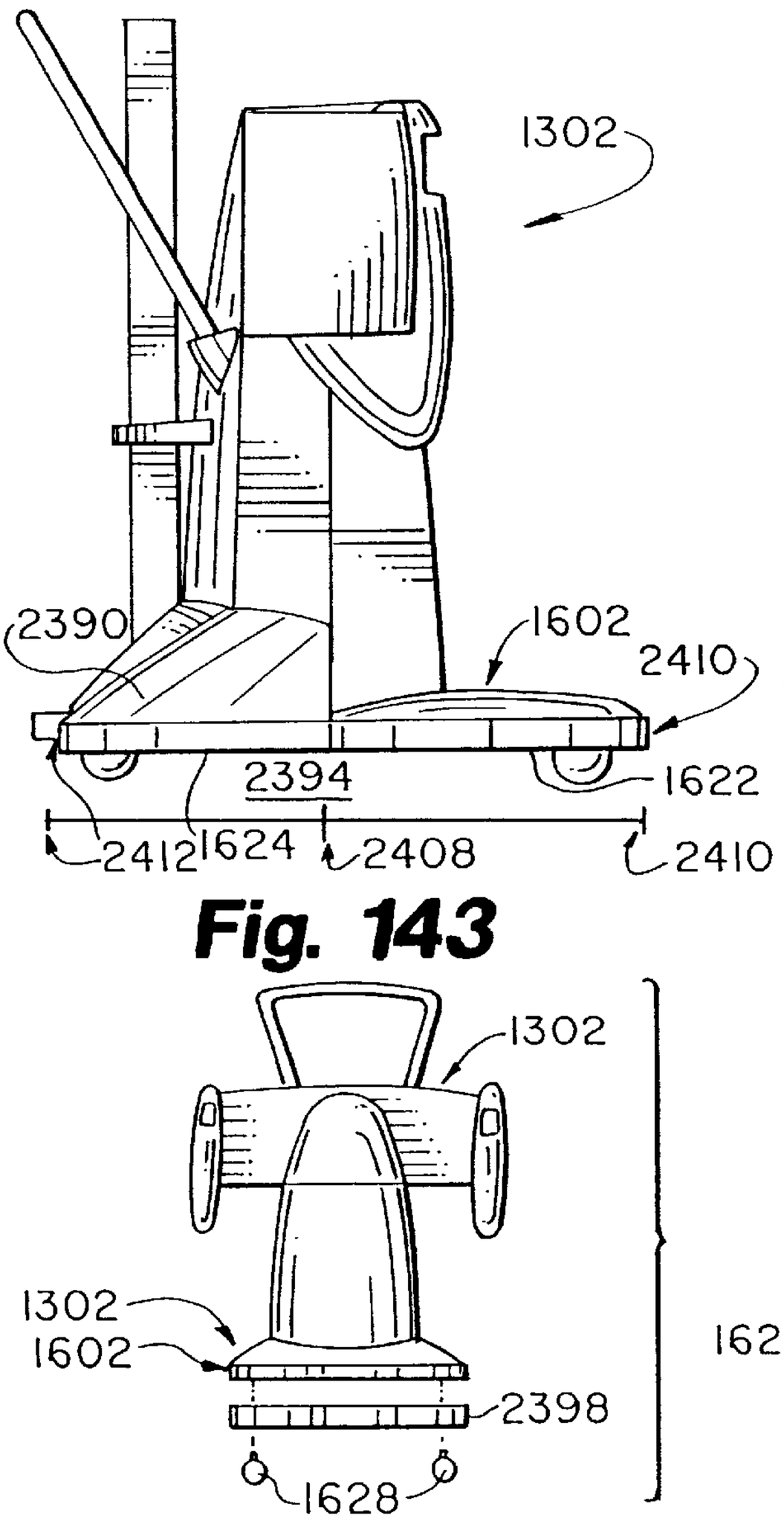


Fig. 142

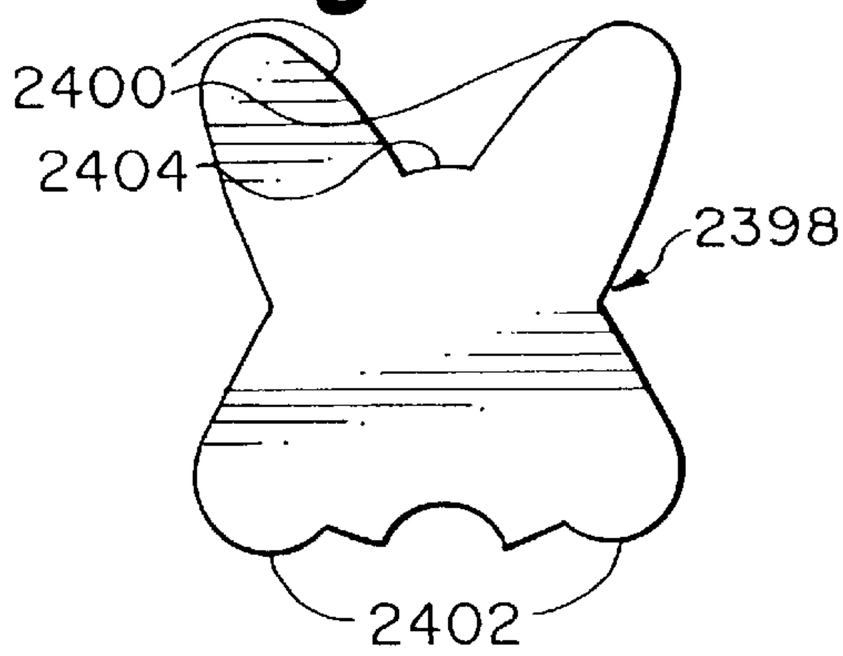


Fig. 143

Fig. 144

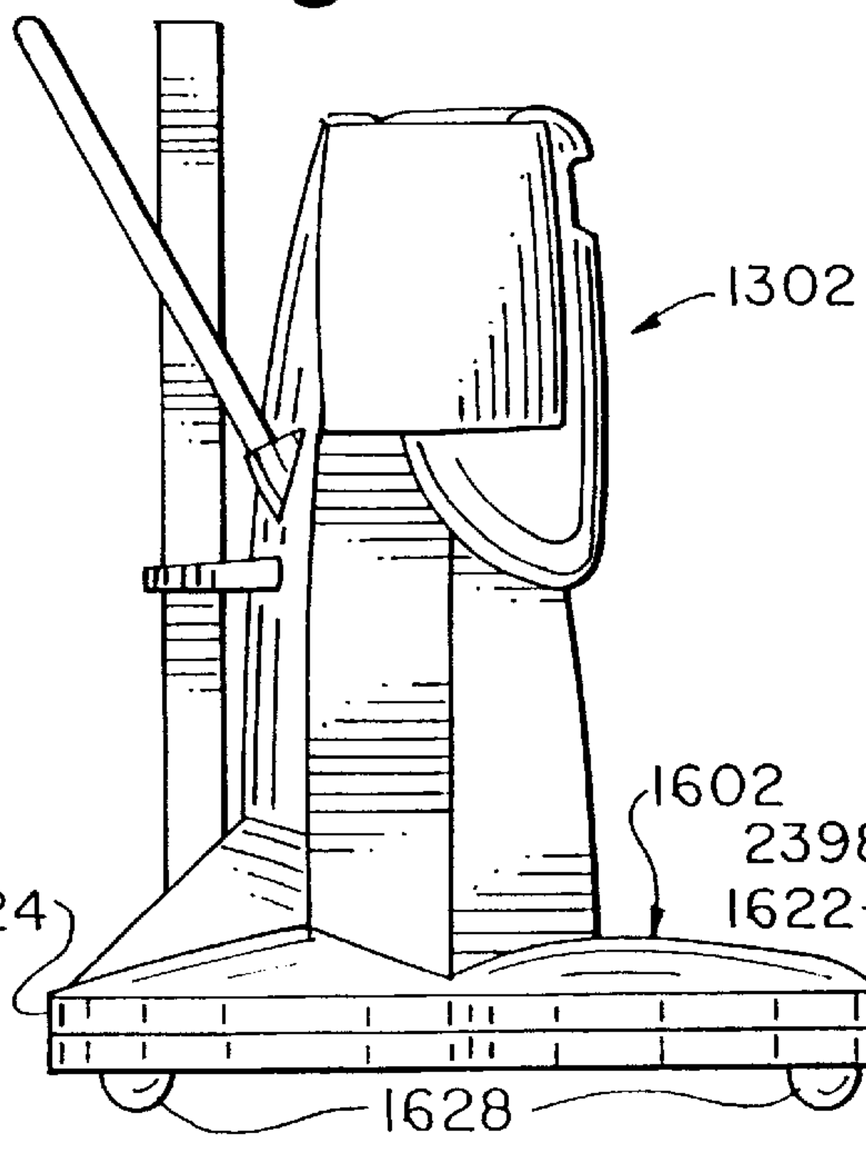


Fig. 148

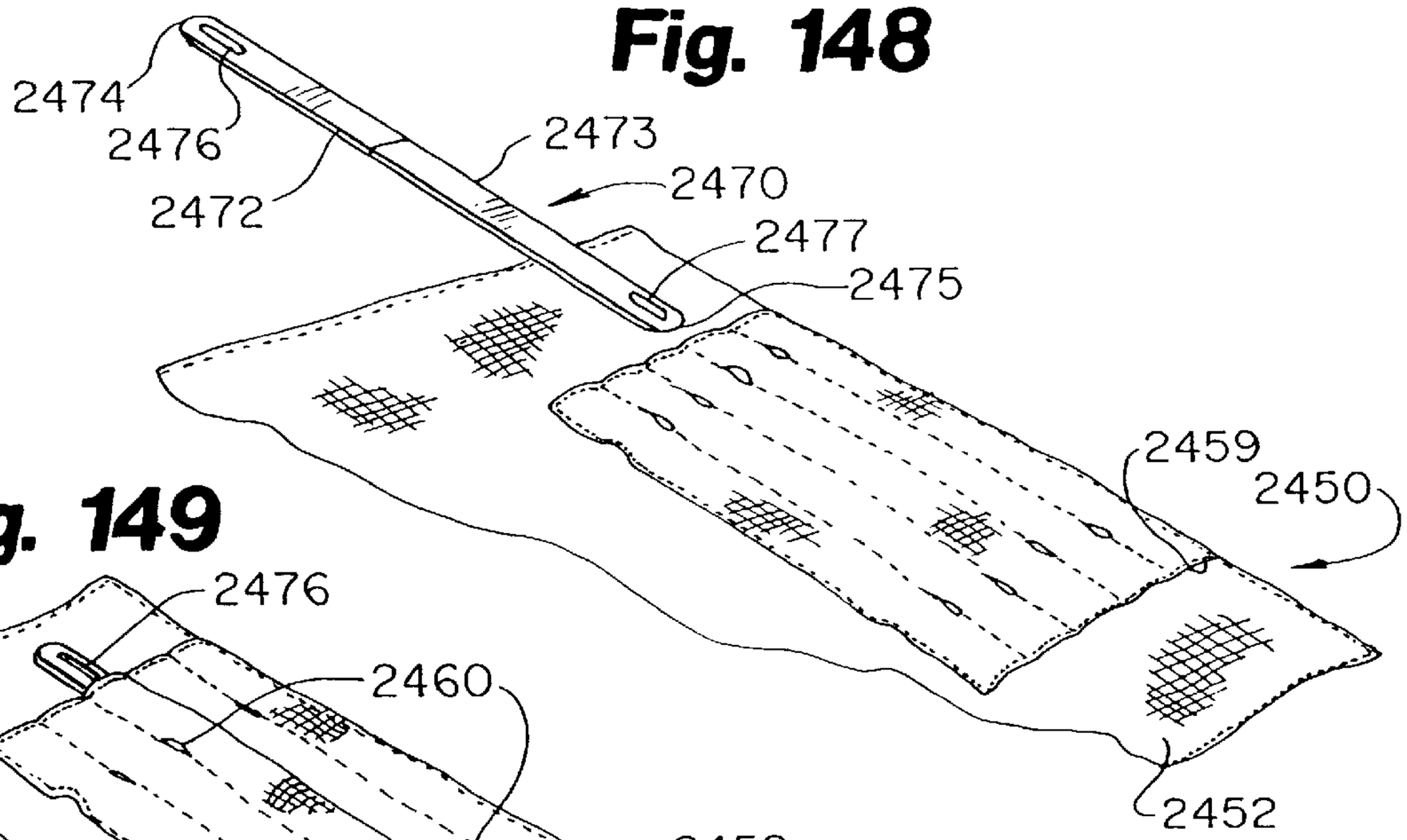


Fig. 149

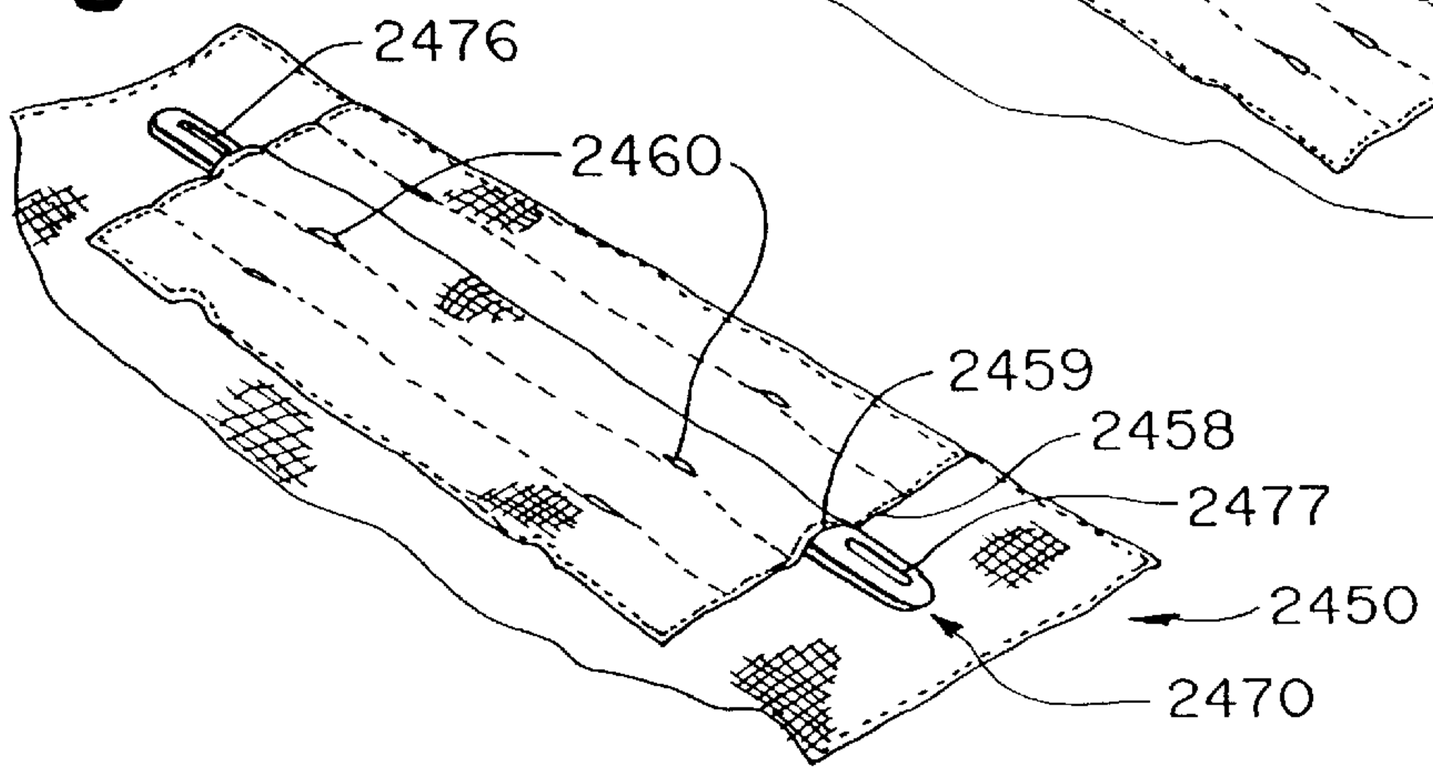


Fig. 145

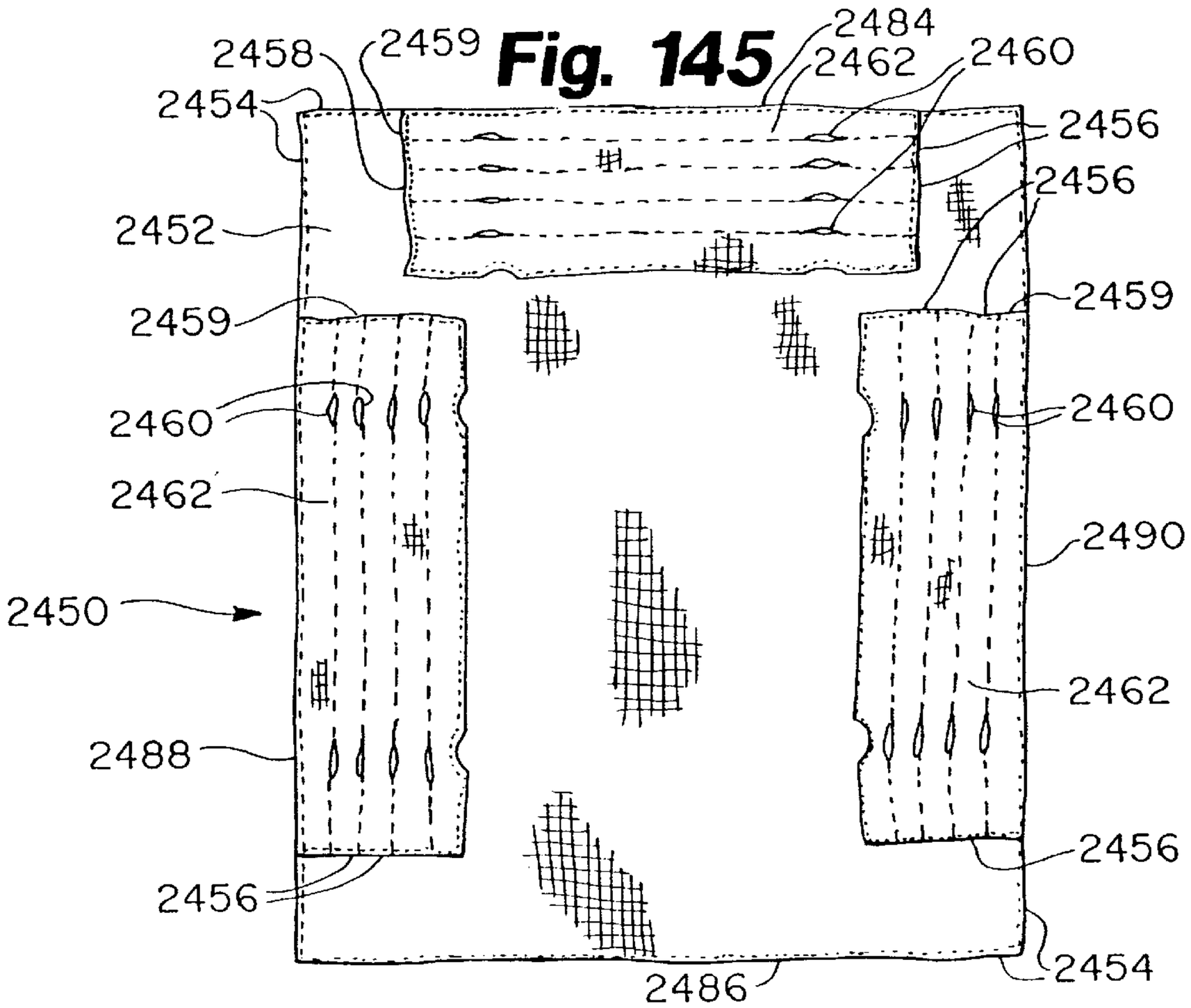


Fig. 146

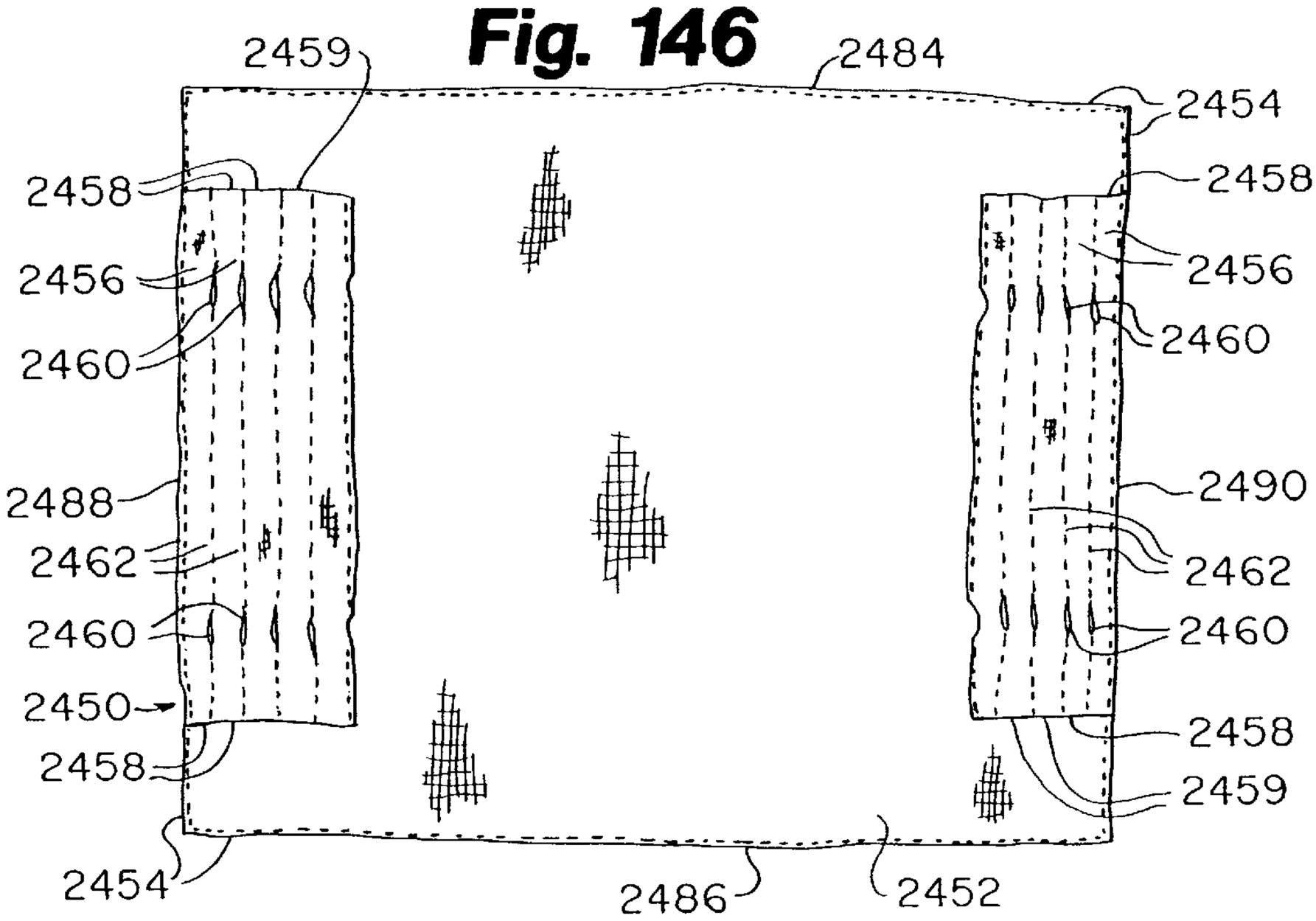


Fig. 154

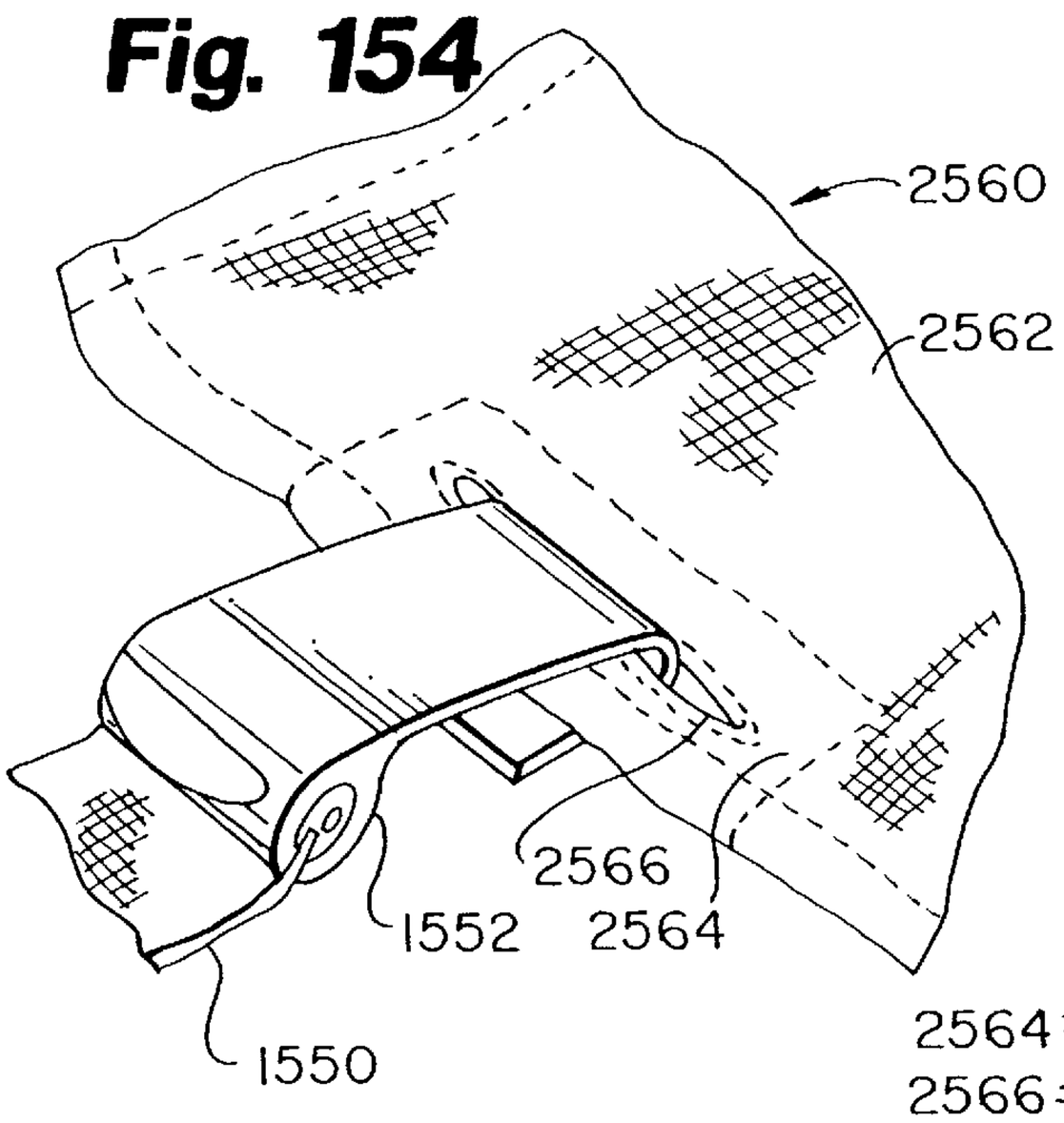


Fig. 155

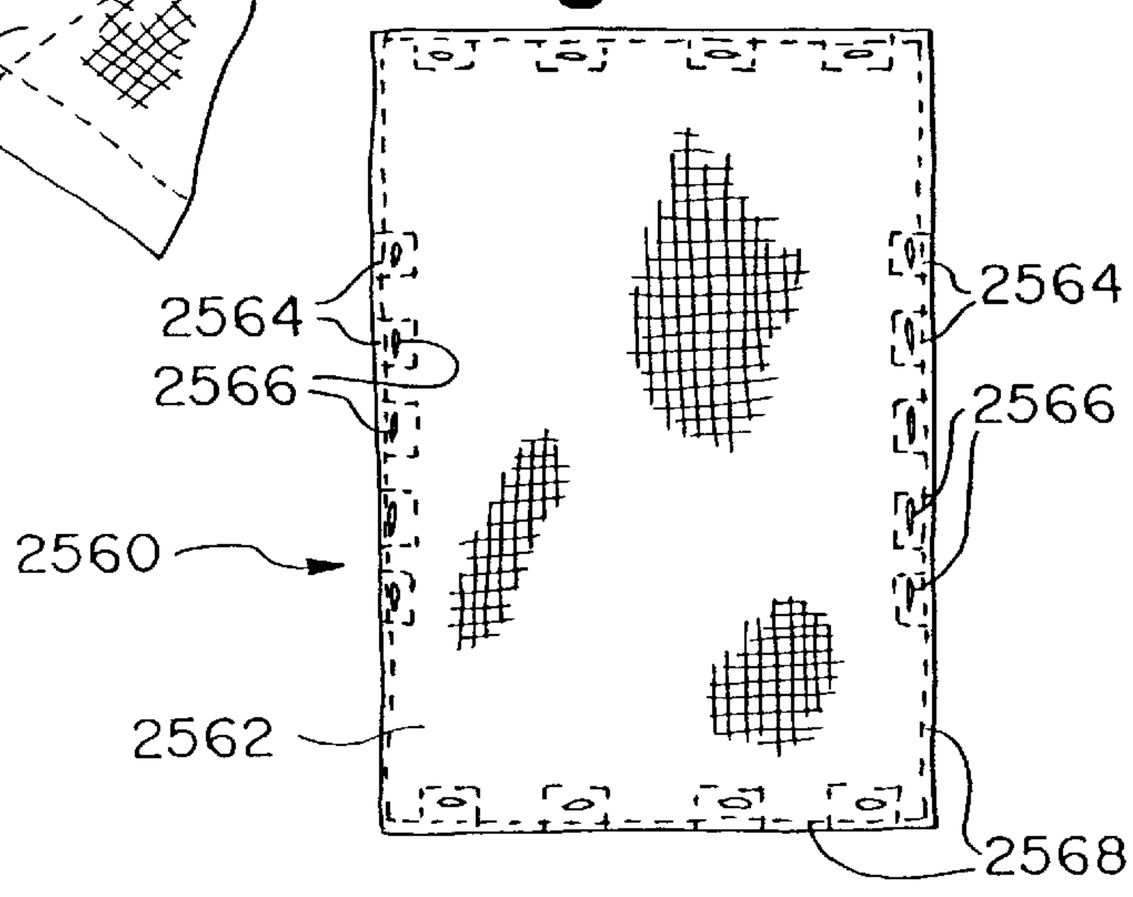


Fig. 147

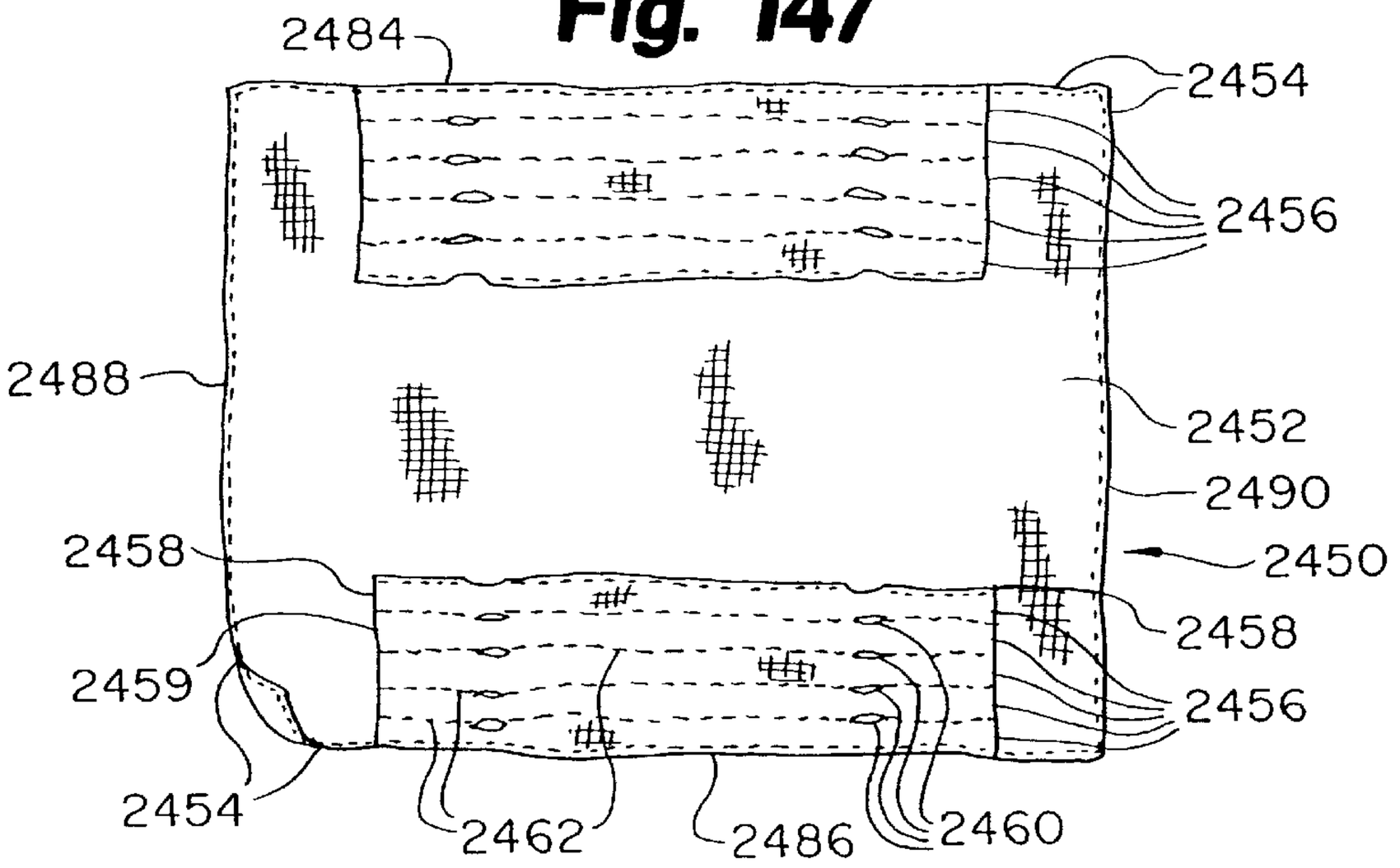


Fig. 150

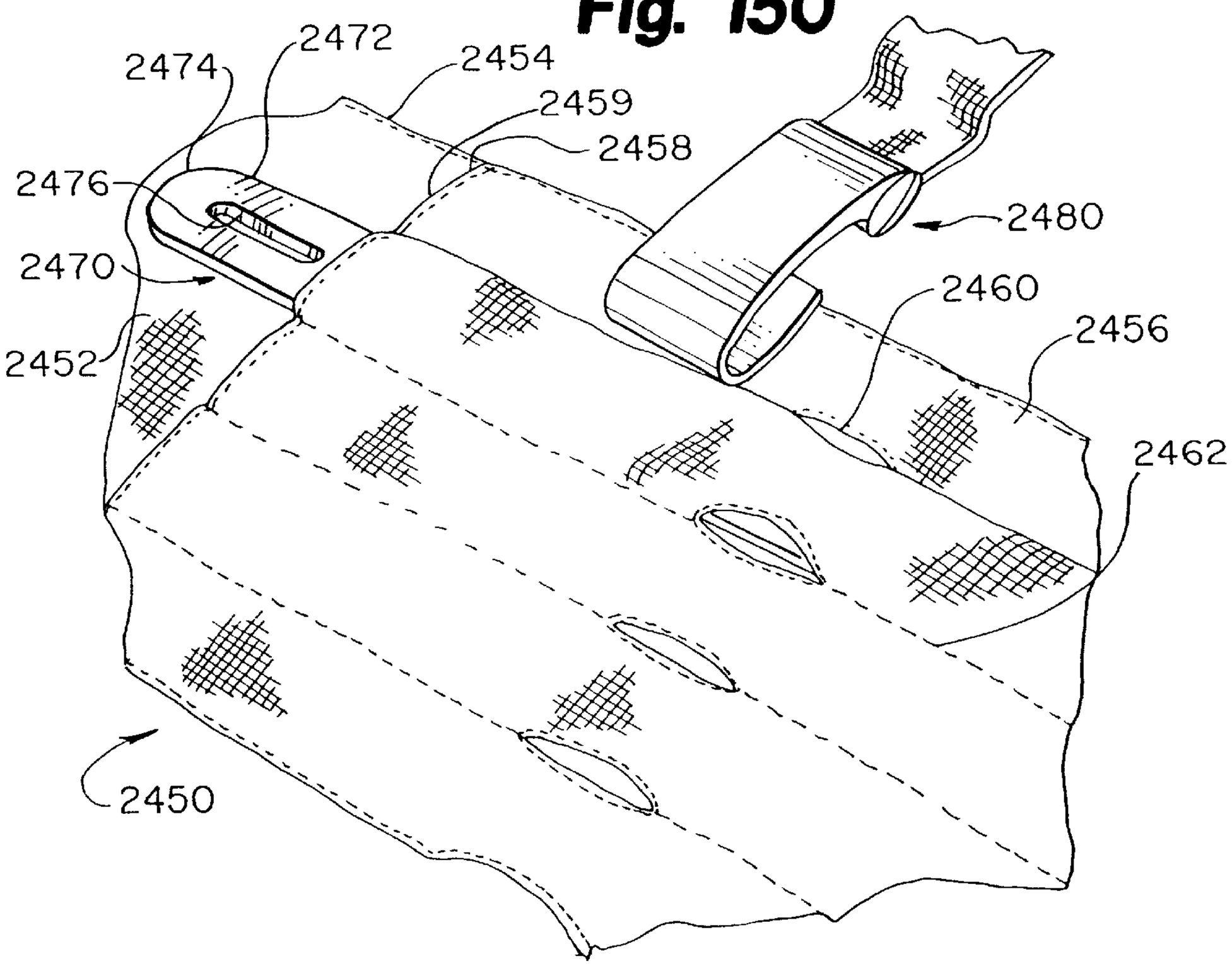


Fig. 151

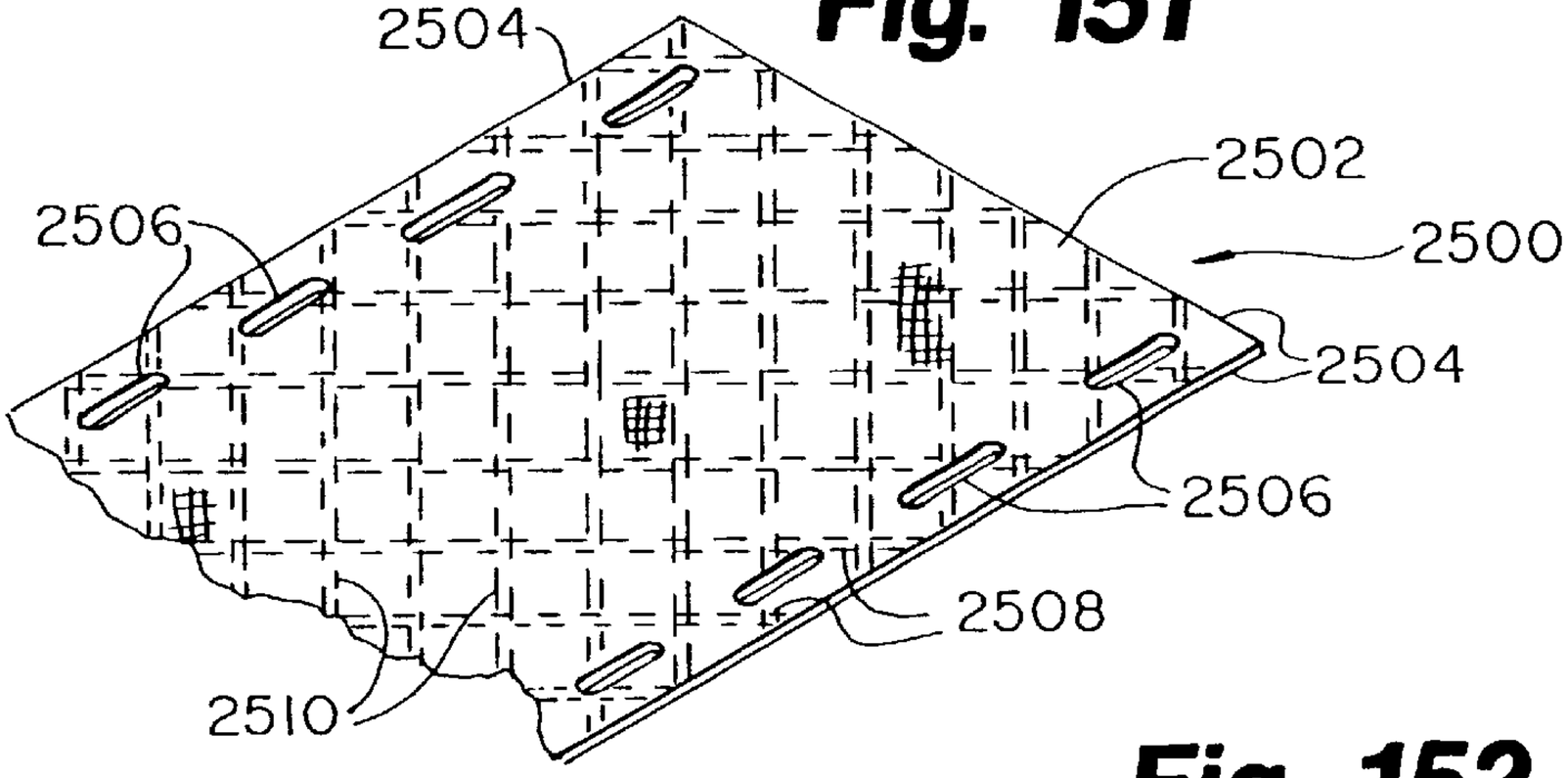


Fig. 152

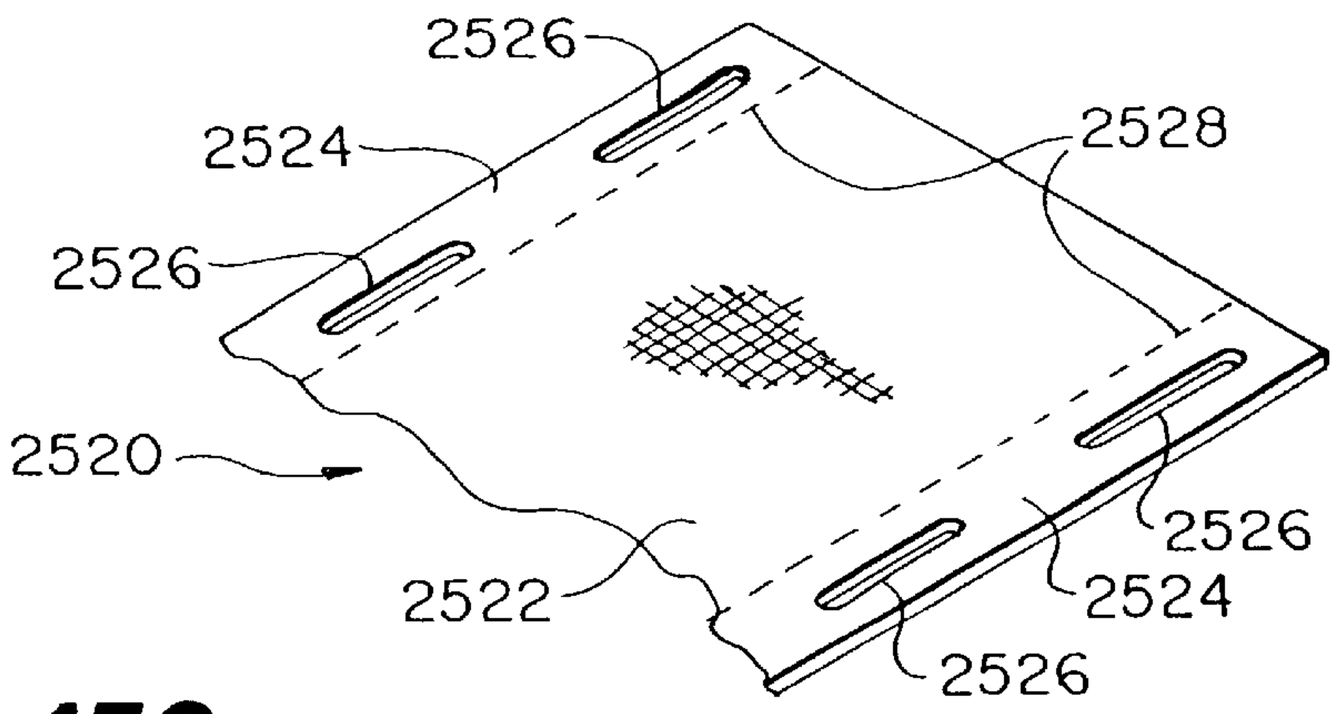


Fig. 153

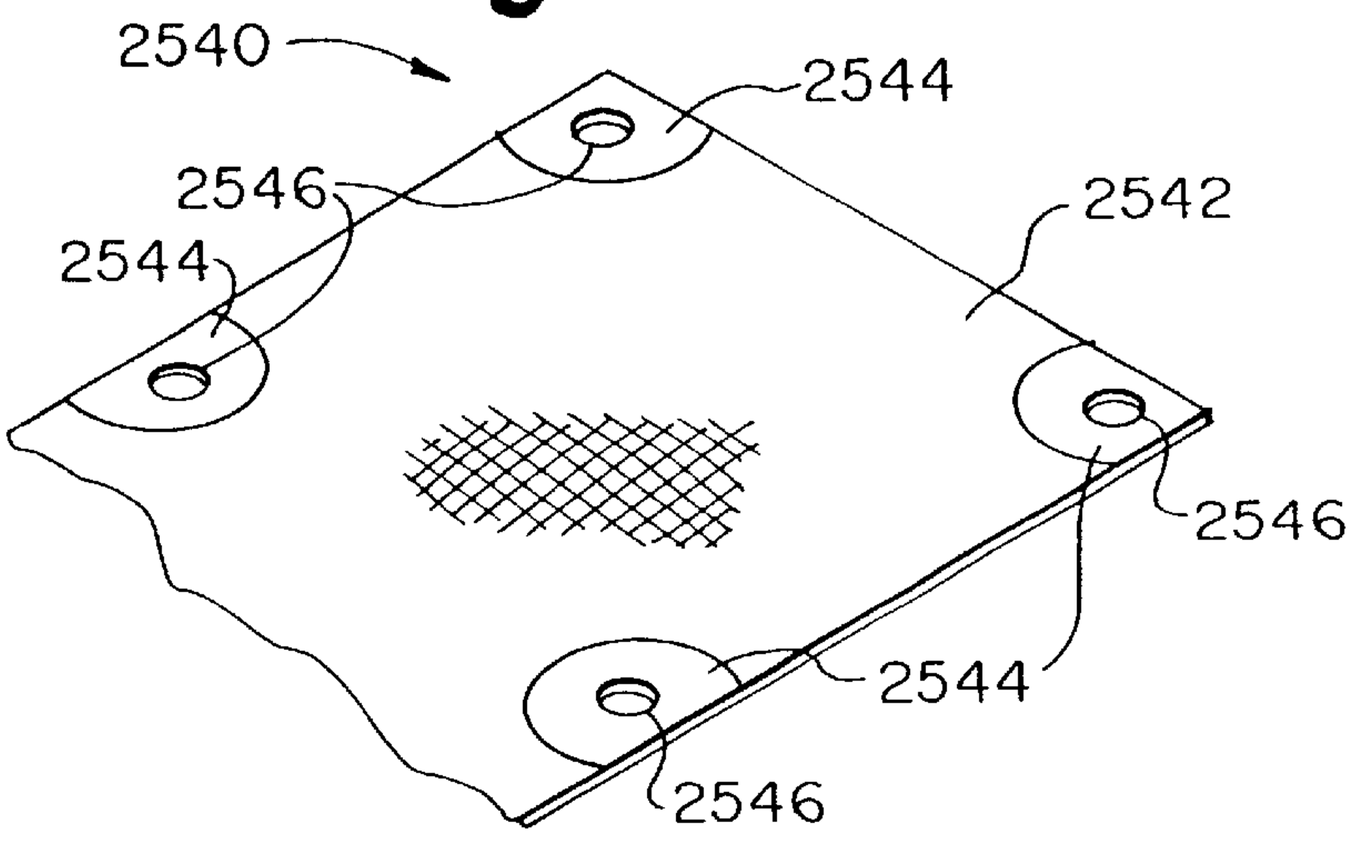


Fig. 156

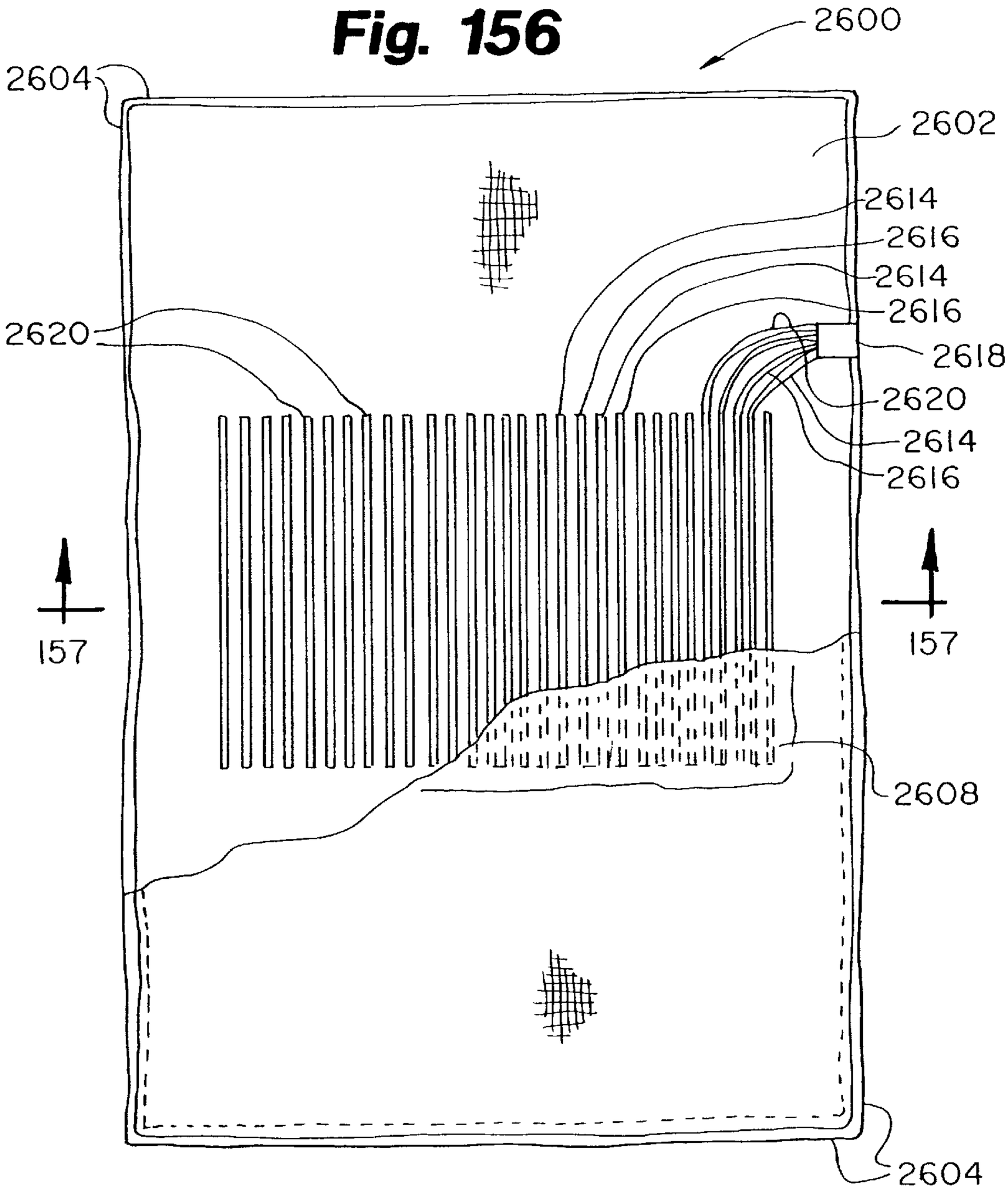


Fig. 157

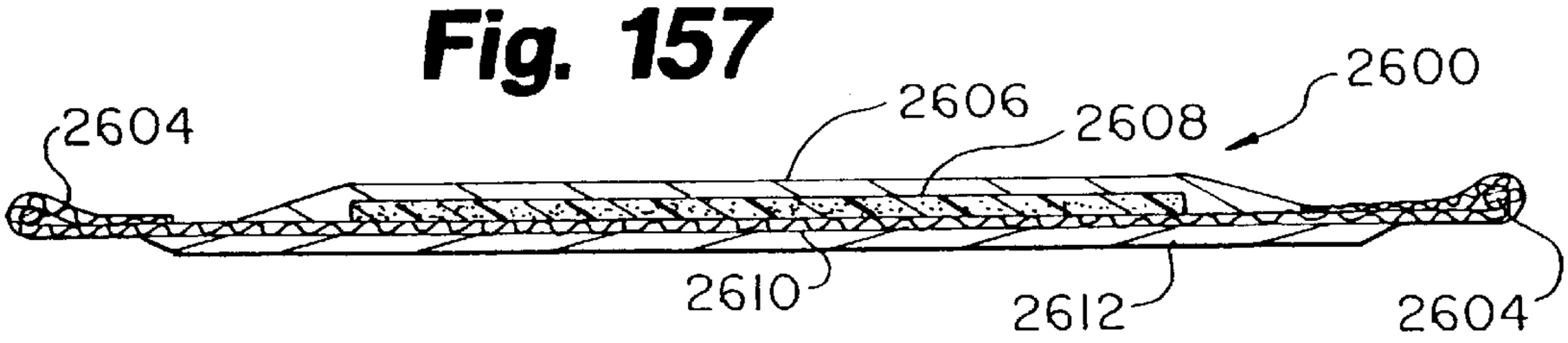


Fig. 158

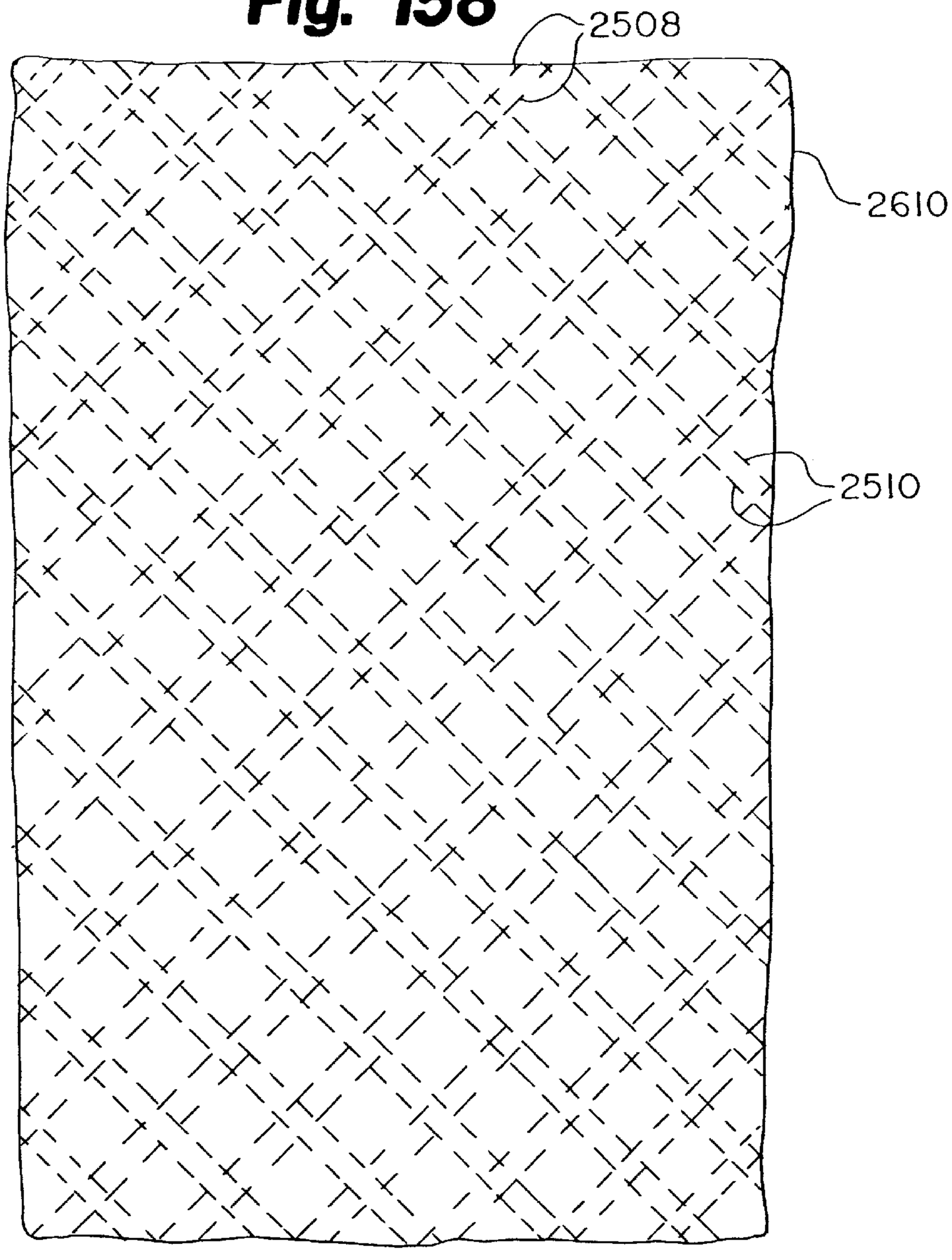


Fig. 159

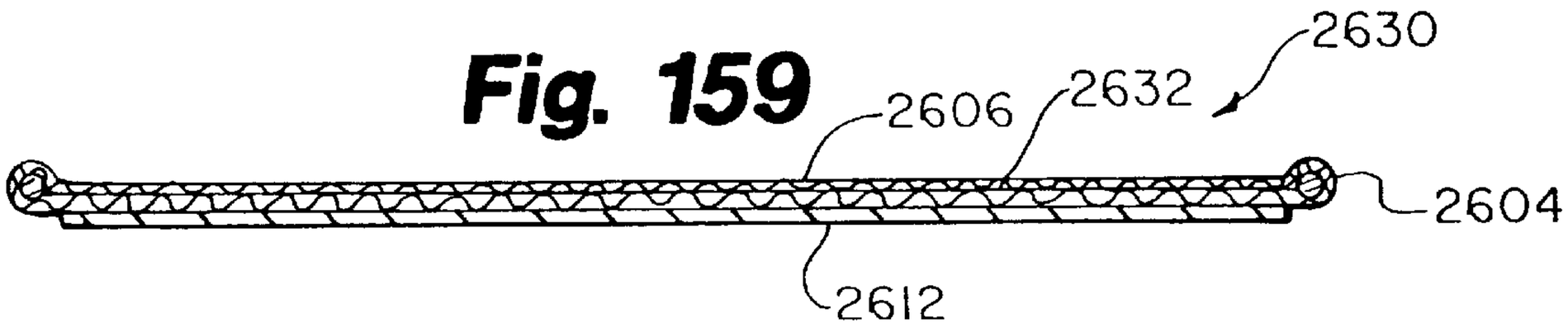


Fig. 160

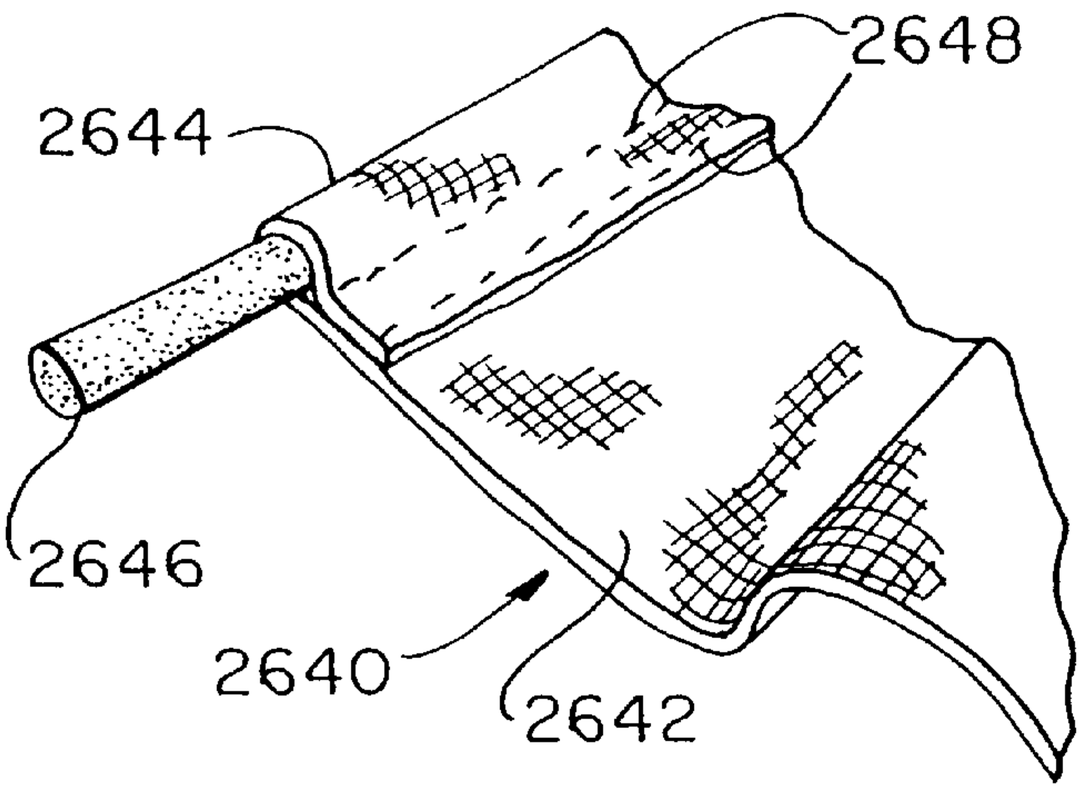
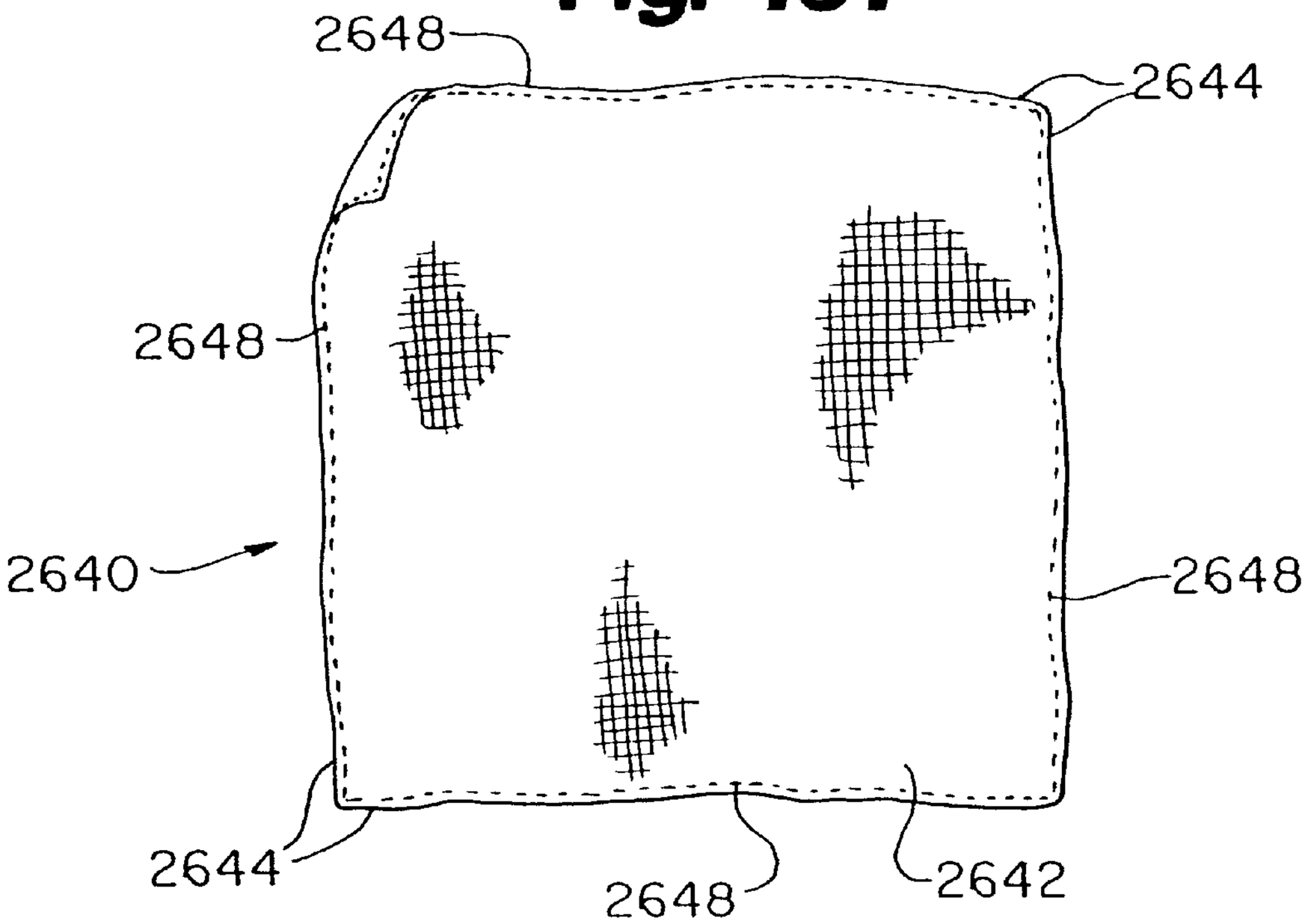


Fig. 161



PATIENT TRANSFER AND REPOSITIONING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. patent application Ser. No. 09/057,139, filed Apr. 8, 1998, which is a continuation-in-part of U.S. patent application Ser. No. 08/713,412, filed Sep. 13, 1996 now U.S. Pat. No. 5,890,238, which is a continuation-in-part of U.S. patent application Ser. No. 08/527,519, filed Sep. 13, 1995 and now U.S. Pat. No. 5,737,781, all hereby incorporated by reference. U.S. patent application Ser. No. 09/057,139 claimed the benefit of U.S. Provisional Patent Application No. 60/043,208, filed Apr. 8, 1997. This Application claims the benefit of U.S. Provisional Application No. 60/084,519, filed May 7, 1998 and U.S. Provisional Patent Application Nos. 60/092,286 and 60/092,287, both filed Jul. 10, 1998, all hereby incorporated by reference.

FIELD OF THE INVENTION

The invention relates to systems which assist in moving, transporting, repositioning, and rolling over patients who are partly or completely incapacitated. The invention more particularly relates to systems which give a single health care worker the capability to move a patient from one bed to another bed, between a bed and a cart or gurney, between a sitting and a standing position, or from a slumped position in a chair or bed to a more elevated position.

BACKGROUND OF THE INVENTION

Health care workers at hospitals, nursing homes, and home care programs face the challenge of moving partly or completely incapacitated patients. A typical patient weighs between 45 and 90 kilograms, although many others weigh more. Consequently, at least two to four health care workers are usually needed to move the patient. These activities often create unacceptable risks of injury, almost without regard to the number of health care workers used in the patient transfer. The risks are particularly high when a sufficient number of workers is not available to assist in a patient transfer. For example, injuries to workers' backs account for approximately 50% of worker's compensation costs for work place injuries in the health care industry in the United States. Thus, back injuries to health care workers are a particularly vexing problem.

Patient transfers can be placed in several broad categories. A first category includes the horizontal transfer of a patient from one flat surface to another. A second category involves upright transfers where a patient is moved from a horizontal position to an upright or sitting position in a wheelchair, chair or commode, and the return of the patient to the horizontal position from an upright or sitting position. A third category of transfer relates to the positioning or movement of patients in order to change their position in a bed or chair, for example pulling the patient up in the bed or rolling the patient from side to side. Although many attempts have been made to devise improved systems for patient transfer, almost all of these transfers continue to be manually performed.

Current healthcare guidelines typically recommend that four health care workers participate in a patient transfer. Two workers are at the bed side and two workers are at the cart side. Each worker grabs an edge of a draw sheet, which is positioned under the patient. The patient is then transferred between the bed and the cart through a combination of lifting, pulling, and pushing. An elongated plastic sheet is often placed beneath the patient to reduce friction or drag. Since a health care worker has to bend over at the waist to accomplish these patient transfers, the stresses encountered are magnified well beyond what would otherwise be expected for a maximum recommended lift of approximately fifty pounds. Normally this recommended maximum lift is measured with the lift at or near the worker's center of mass. Extremes in a health care worker's height, either taller or shorter than average, or any weakness in either the arms or legs further exaggerate these risks.

Many hospitals have swing-type mechanical lift devices to assist in certain patient transfers. However, these devices are not widely used because they are often cumbersome and time-consuming to set up and operate. Depending on the lift required, the devices may also be inappropriate.

The upright transfer and positioning categories provide similar difficulties, especially if the patient is unable to cooperate. For example, weak and elderly patients reclining in a semi-erect position tend to slide down. These patients must be returned to a position more toward the head of the bed. To do so, two health care workers usually grasp the patient by the upper arms to hoist the patient toward the head of the bed after the bed has been lowered to a more horizontal position. This manual transfer often causes strain on the workers' upper and lower backs and possible contact bruises on the patient. Similar difficulties occur with upright transfers.

Given these formidable difficulties, there have been other attempts to mechanize the patient transfer process. For example, U.S. Pat. No. 2,665,432 (Butler), describes a cart with a manual crank connected to an extensive pull unit. The pull unit has a large number of straps which connect at an edge by hooks to a transfer sheet. Rotation of the crank winds the pull unit onto a roller. The size of the pull unit presents many difficulties including it attachment at many locations to the sheet and the awkwardness of winding it on the roller. The pull unit must be placed under the patient just prior to transfer, since it would not normally be kept there. Also, no means are provided for transferring the patient off the cart.

U.S. Pat. No. 2,827,642 (Huff) describes a similar system mounted to the head of a bed and designed to move a patient from the foot toward the head of the bed. The '642 Patent does not describe the process of moving a patient laterally from one horizontal surface to another.

U.S. Pat. No. 4,970,738 (Cole) discloses another patient transfer system which employs a manual crank and self-locking gear system. This system has an advantage over the system described in the '432 patent in that the transfer is reversible. Rotating the crank drives a belt system, which is attached to a semi-rigid transfer apron. The apron is thereby transferred horizontally while supporting a patient. This system has the disadvantage that the apron must be first positioned under the patient before the patient can be transported from a bed onto a cart. Another disadvantage is that the transfer support alone does not provide sufficient support for the patient or the transfer system. Because of the complexity of its design, considerable operator interaction would be required for the transfer support to be mounted to a cart and then operated to transfer a patient.

U.S. Pat. No. 2,733,452 (Tanney) describes a transfer system that uses a motorized pulley to transfer a patient on a metal-reinforced transfer sheet. The transfer sheet has metal grommets in its corners for attachment to cables. A

motor is used to wind the cables onto reels thereby resulting in the transfer of the sheet and the patient thereon. However, the patient must first be moved onto the transfer sheet before being moved from a bed to the cart. Moreover, this invention fails to provide support beneath a patient being transferred.

U.S. Pat. Nos. 4,747,170 and 4,868,938 (both to Knouse) reveal a motorized winch-type transfer system. This transfer system has apparent advantages over the transfer system of the '452 patent, which include a more secure transfer sheet gripping mechanism and the use of a transfer sheet which does not need grommets or other similar devices. Though more secure, the gripping system is difficult and awkward to use.

U.S. Pat. No. 5,038,424 (Carter et al.) teaches a system for reciprocally transferring a patient between a bed and a cart. This system employs a pliable transfer web wound about two detachable, cylindrical rollers and a drive motor mounted on the bed and the cart. In use, the bed and cart are positioned side-by-side and the web is placed beneath the patient. The roller adjacent the cart or bed onto which the patient is to be transferred is detached. While unwinding a sufficient length of transfer web wound thereon, the roller is extended to the opposite side of the bed or cart onto which the patient is to be transferred, and there connected to the drive motor. The drive motor is then activated, thereby rewinding the transfer web onto the roller and transporting the patient disposed thereon. Thus, while enabling reciprocal transfer, the system of the '424 patent is time consuming and awkward to set up. Moreover, as in the previous inventions discussed hereinabove, the patient is not supported adequately while being transferred.

While considerable effort has gone into developing horizontal patient transfer systems, all of the systems previously developed have significant drawbacks. These drawbacks primarily relate to the significant difficulties encountered in set-up and operation.

The patents described hereinabove primarily relate to systems for transferring patients from one horizontal surface to another horizontal surface. By partial contrast, U.S. Pat. Nos. 4,700,415 and 4,837,873 (both to DiMatteo et al.) teach a system for transferring patients between a reclined wheelchair and a bed. The bed is equipped with a sheet wound about a right side roller and a left side roller. The sheet is positioned beneath a patient reclining thereupon. The right and left side rollers are positioned laterally on each side of the bed, usually slightly below the plane of the patient. Two corner rollers are situated above the right side and left side rollers. The two corner rollers are approximately level with the top surface of the bed. The reclined wheelchair is equipped with two articulated rollers. Extending between these articulated rollers is a sheet, the sheet including three bands. The lateral edges of the sheet may be joined or separate. If the lateral edges are to be joined, the sheet spans above and below the wheelchair upper surface. If the lateral edges are free, the sheet spans the wheelchair upper surface with its ends wound about the two rollers. The separate transfer systems for the bed and wheelchair must be powered such that both sheets rotate with equal velocities. In use, the patient reclining upon the bed is conveyed laterally by the bed transfer system. Upon encountering the wheelchair transfer system, the patient is thereupon further conveyed onto the wheelchair. The wheelchair may then be further adjusted, allowing the patient to assume a sitting position.

The system of DiMatteo allows for transfer to or from a reclining wheelchair and for adjusting the wheelchair between sitting and reclining positions. However, its shortfalls include the complexity of its design, the need to retrofit beds with the rollers and sheet provided, and the possibility of pinching the patient or catching clothing in the gaps between the bands.

U.S. Pat. No. 3,597,774 (Warren) describes a harness and winch mechanism for raising a patient reclining upon a bed. The winch is mounted to a post attached to the head of the bed and is operated by a hand crank. The harness loops under the patient's armpits such that excessive stress may be applied thereto during operation of the device.

SUMMARY OF THE INVENTION

The invention includes devices for transferring patients which greatly simplify, and provide enhanced versatility over, any known device. The adoption of these transfer devices will likely reduce the wide incidence of back injuries in health care workers. A first system for the horizontal transfer of patients is adapted to use existing transfer sheets and an appropriately modified cart. The sheet is readily attached to a clamping device close to the patient. The clamping device has a releasable catch which holds the sheet. One or more straps are attached to the clamping device, and the other ends of the straps are attached to reels that are part of a winch. Activation of the winch winds the straps onto the reels. In a highly portable embodiment of this transfer device, the entire apparatus may weight only about 8–15 kilograms, and may be readily attachable and removable to bed and cart rails.

A long narrow rectangular cushion can be placed between the bed and cart when using the portable transfer device. The cushion is, optionally, the length of the bed, and may be partially coated with a low friction surface. The cushion may have fasteners for attachment to a bed or cart, or it may also be configured to hang from the side of the bed or cart by the fasteners when not in use. The cushion is particularly convenient when used with a portable transfer device of the invention because no other modifications to the bed or cart may be needed.

Other embodiments of horizontal transfer devices facilitate the transfer of the patient by providing some lift to the patient as well as horizontal motion. The vertical and horizontal transfer mechanisms may both be operably attached to a single bed or cart frame. One embodiment of a horizontal transfer mechanism within the invention has a transfer element that moves within tracks. Another embodiment of a horizontal transfer system of the invention moves the patient on a modularized cushion. In other embodiments, lift is added by use of a harness which provides significant advantage in distributing the weight of the patient without the need to lift the patient to place a portion of the harness under the patient. The harness has a support that goes across the patient's upper body. Another portion of the harness goes under the patient's arms. The harness has a fastener that attaches a lift mechanism near the back of the patient's head.

An improved patient transfer system is capable of transferring a patient using only a single attendant. The transfer system includes patient transfer means for transferring the patient, a transfer sheet, a retaining member assembly operably coupled to the patient transfer means and a contact element assembly.

The improved transfer system may also include a highly portable transfer unit. The portable transfer unit may be totally self-contained or may be installable on a bed or cart and connectable to a separate clamp. The portable transfer unit may utilize a plurality of detachable spools, as well as means for sensing the proximity of a patient being transferred and means for discontinuing the transfer in response to the sensing.

The improved transfer system may still further include a transfer bridge support means for supporting a patient being transported when the patient spans the bed or cart. The transfer bridge support means may be foldable and may include a stabilizer, a cross sectional camber and a leading edge camber to further prevent the transfer bridge support means from being displaced during patient transfer, and improved slip-resistant features.

A system for enabling a person to singly and ergonomically transfer a patient disposed on a sheet as provided. The system may include a caddy. The caddy may include means for enabling the person to transport the caddy from a first location to a second location, a power train, a hook and web assembly attachable to the power train, a power and switching system in electrical communication with the power train, and means for adjusting a vertical position of the hook and web assembly. The transport means may be operably disposed proximate the caddy. The system may further include means for gradually accelerating and decelerating a transfer force exerted by the power train. The power train may include a motor and a plurality of spools in mechanical communication with the motor. The plurality of spools may further be in mechanical and magnetic communication with the motor. The power train may still further include a plurality of magnetic clutch assemblies and a plurality of slip plates. Each magnetic clutch assembly may be in mechanical communication with the motor and each slip plate may be in magnetic communication with one of the magnetic clutch assemblies. Each spool may be in mechanical communication with one of the slip plates.

The hook and web assembly may include a plurality of webs and a plurality of transfer hooks, each web being connectable to one of the spools and each transfer hook being connectable to one of the webs. The power and switching system may further include means for automatically discontinuing a transfer. The system may provide a transfer rod, the transfer rod accommodating the transfer hook when at least a portion of the transfer sheet is wrapped around the transfer hook. The transfer rod may include a plurality of joinable sections, the sections may be elastically connected.

The system may further include a transfer bridge. The transfer bridge may further include a low-friction surface and a plurality of sections, foldable into a generally facing relationship.

There is also provided a movable caddy for enabling a single person to ergonomically turn a patient disposed on a sheet in cooperation with sheet-gripping means or to transfer the patient from a first horizontal surface to a second horizontal surface in cooperation with the sheet-gripping means. The caddy may include a base assembly, the base assembly including means enabling a single person to transport the caddy from a first site to a second site, a vertical adjustable head assembly, the vertical adjustable head assembly including a power train, the power train including a motor, a plurality of magnetic clutches, a plurality of slip plates, and a plurality of spools. Each magnetic clutch may be in mechanical communication with the motor. Each slip plate may be in magnetic communication with one of the magnetic clutches. Each spool may be in mechanical communication with one of the slip plates. The magnetic clutches and the slip plates may cooperate to exert a gradually accelerable transfer force. The system may further include a hook and web assembly with a plurality of webs and means for gripping the sheet. A first end of each web may be windably attachable to one of the spools. The sheet-gripping means may be attachable to a second end of each of the belts. The sheet-gripping means may grip a portion of the sheet, thereby transmitting the transfer force to the gripped sheet. The sheet-gripping means may include a plurality of transfer hooks and a transfer rod. Each transfer hook may be attachable to a second end of each belt and each transfer hook may cooperate with a transfer rod to grip the sheet.

There is also provided a transfer rod for cooperatively gripping and exerting a transfer force on a sheet. A portion of the sheet may be partially enwrapped around the transfer rod, the transfer rod exerting the transfer force in cooperation with the plurality of transfer hooks. The transfer rod may include means for mating with the transfer hooks.

There is also provided a transfer bridge. The transfer bridge may include a first inboard member, a plurality of outboard members, means for interfolding the inboard and outboard members, and means for reducing friction arising from contact between a sheet and the transfer bridge. An outboard member may extend from a lateral edge of the first inboard member. The transfer bridge may include a second inboard member and an outboard member may extend from each inboard member.

There is provided a substantially pliable underlayment for transferring, repositioning, or rolling a patient disposed thereon, the underlayment including a substantially smooth mantle proportioned to accommodate at least a central portion of the patient's body, an attaching structure operably adjacent the mantle, and a reinforcing structure for imparting a resistance to distortion of the mantle in response to a force exerted on the attaching structure.

There is also provided a method of transferring or repositioning a patient disposed on a substantially pliable underlayment, the method comprising the steps of providing the substantially pliable underlayment, the underlayment including a substantially smooth and pliable mantle, an attaching structure operably adjacent the mantle, and a reinforcing structure for imparting a resistance to distortion of the mantle in response to a force exerted on the attaching structure; attaching a connecting member to the attaching structure; and exerting the force on the connecting member, the force being sufficient to displace the patient.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a bed with an adjacent cart adapted with a first embodiment of a horizontal patient transfer system;

FIG. **2** is a front, schematic view of a cart adapted with the first embodiment of a horizontal patient transfer system with side rails in a lowered storage position;

FIG. **3** is a front, schematic view of a cart adapted with the first embodiment of a horizontal patient transfer system with side rails in a raised patient transport position;

FIG. **4** is a front, schematic view of a cart adapted with the first embodiment of a horizontal patient transfer system with one side rail in a raised position and a second side rail in a bridge position used during patient transfer;

FIG. **5** is a front fragmentary view of one embodiment of hinges supporting a side rail;

FIG. **6** is an exploded view of a side rail of the first embodiment of a horizontal transfer system;

FIG. **7** is a cut away view of a second drive system within the side rail;

FIG. **8** is a perspective view of a first embodiment of a clamping device useful with a first embodiment of the horizontal transfer system in an orientation to be clamped to a transfer sheet folded over a rod;

FIG. **9** is an end view of a first embodiment of the clamping device;

FIG. **10** is a perspective view of a second embodiment of the clamping device;

FIG. **11** is an end view of the second embodiment of the clamping device;

FIG. **12** is a perspective view of a third embodiment of the clamping device;

FIG. **13** is an end view of the third embodiment of the clamping device;

FIG. **14** is a perspective view of the attachment of a portable horizontal transfer device for the transfer of a patient from one horizontal surface to another;

FIG. **15** is a perspective view of the portable horizontal transfer device;

FIG. **16** is an exploded view of the portable horizontal transfer device;

FIG. **17** is a perspective view of a portable cushion attached to a horizontal surface to provide a smooth continuous surface for the transfer of a patient with the portable horizontal transfer system, with the cushion in a lowered, stored position shown in phantom lines;

FIG. **18** is a perspective view of a further embodiment of a horizontal transfer system;

FIG. **19** is a partial, cut away perspective view of the further embodiment of the horizontal transfer system showing the drive system for horizontal extensions;

FIG. **20** is a perspective view of the further embodiment of the horizontal transfer system with a patient elevated over a cart to indicate the ranges of motion obtainable by the transfer system;

FIG. **21** is a perspective view of the further embodiment of the horizontal transfer system with an alternative design for the horizontal drive;

FIG. **22** is a fragmentary perspective view of a sheet clamp indicating its motion relative to a lifting support and its attachment to a transfer sheet;

FIG. **23** is a perspective view of a bed equipped with the further embodiment of the horizontal transfer device with the bed in a raised position;

FIG. **24** is a partial perspective view of one end of the embodiment of FIG. **21** with an arrow showing the disengagement of a removable panel;

FIG. **25** is a partial perspective view of one end of the embodiment of FIG. **21** with a removable panel attached as a shelf;

FIG. **26** is a perspective view of a portion of the foot board bed or cart adapted with the further embodiment of the horizontal transfer system indicating a location for the attachment of a control unit;

FIG. **27** is a top view of a transfer sheet designed for use with the further embodiment of the horizontal transfer system;

FIG. **28** is a perspective view of the transfer sheet of FIG. **27** shown in its folded position;

FIG. **29** is perspective view of an alternative embodiment of the horizontal transfer system;

FIG. **30** is a perspective view of a portion of the alternative embodiment of FIG. **29** showing extendable horizontal supports;

FIG. **31** is a perspective view of the alternative embodiment of FIG. **29** being used to assist a patient to sit up;

FIG. **32** is a perspective view as in FIG. **31** indicating the rotation of a lifting element;

FIG. **33** is a perspective view of a transfer system with a horizontal transfer mechanism;

FIG. **34** is a cut away side view of one embodiment of a docking mechanism;

FIG. **35** is a cut away side view of a second embodiment of a docking mechanism;

FIG. **36** is a perspective view of the transfer system of FIG. **33** with a transfer element bridging between a bed and a cart;

FIG. **37** is a perspective view of a transfer bridge used with the transfer system of FIG. **33**;

FIG. **38** is a perspective view of the transfer bridge of FIG. **37** with the bridge in the bridging position;

FIG. **39** is a side view of the transfer bridge in the bridging position with lever and rods removed;

FIG. **40** is a side view of the transfer bridge in the raised position with lever and rods removed;

FIG. **41** is a perspective view of a split transfer bridge;

FIG. **42** is a perspective view of a mattress transfer system;

FIG. **43** is a perspective view of a docking mechanism used with the mattress transfer system of FIG. **42**;

FIG. **44** is a perspective view of a gripping mechanism of the mattress transfer system in pushing position;

FIG. **45** is a perspective view of a gripping mechanism of the mattress transfer system in pulling position;

FIG. **46** is an exposed, top perspective view of a mattress and fixed cushion of the mattress transfer system indicating the location of structures within and below the mattress and cushion;

FIG. **47** is a perspective view of a mattress transfer system used with a position changing cart and a folding mattress;

FIG. **48** is a perspective view of the mattress transfer system and position changing cart depicting the cart in a folded position;

FIG. **49** is a side view of the position changing cart in the chair orientation;

FIG. **50** is a perspective view of a lobster claw type of bed jacket being placed on one side of a person;

FIG. **51** is a perspective view of the bed jacket in place around a person;

FIG. **52** is a perspective view of the bed jacket secured around a person and hooked to a hoisting mechanism;

FIG. **53** is a perspective view of a motorized bed jacket attached to a stand above a wheel chair;

FIG. **54** is a front view of a padded vest;

FIG. **55** is a perspective view of the padded vest around a person and attached to a tether where hidden portions of the vest are depicted with phantom line;

FIG. **56** is a perspective view of a motorized bed jacket being attached to a mount above a headboard;

FIG. **57** is a top perspective view of the motorized bed jacket;

FIG. **58** is a partial cut away view of the drive system of the motorized bed jacket;

FIG. **59** is a perspective view of a bed jacket attached to three hoisting mechanism on a ceiling using a three way control cylinder;

FIG. **60** is a side perspective view of the three way control cylinder;

FIG. **61** is a schematic view of the internal components of the three way control unit;

FIG. **62** is a top right perspective view of another clamp embodiment of the present invention;

FIG. **63** is a side plan view of the clamp of FIG. **62**, in an open position;

FIG. **64** is a side plan view of the clamp of FIG. **62** in a closed, locked position;

FIG. **65** is a top perspective view of another clamp embodiment of the present invention, the clamp disassembled and depicted in an exploded view;

FIG. **66** is a top perspective view of the clamp of FIG. **65** assembled;

FIG. **67** is a top plan view of another clamp of the present invention;

FIG. **68** is a side plan view of the clamp embodiment of FIG. **67**;

FIG. **69** is another embodiment of the transfer system of the present invention, whereby a patient may be bidirectionally transferred without the necessity of reinstalling this embodiment on another bed or cart;

FIG. **70** is a side plan view of the embodiment of FIG. **69**, wherein a patient is being transferred away from the bed on which the embodiment is installed;

FIG. **71** is a side plan view of the embodiment of FIG. **69**, wherein a patient is being transferred onto the bed or cart onto which the embodiment is installed;

FIG. **72** is a top, side perspective view of a remote control usable for any of the embodiments described herein;

FIG. **73** is a top, side view of a remote control, which may be used for any of the embodiments described herein;

FIG. **74** is a top, side perspective view of a portable transfer device and clamp installed onto a hospital bed;

FIG. **75** is a top, side perspective view of an embodiment of the portable transfer device, wherein a spool or reel may be detachably installed onto a drive shaft;

FIG. **76** is a side plan view of any of the portable transfer devices of the present invention depicting a reel for winding a retraction belt, wherein an automatic cutoff device is operationally installed;

FIG. **77** is another embodiment of a portable transfer device installed onto a bed, and wherein one of the clamps of the present invention is connected thereto by means of belts;

FIG. **78** is a side view of any of the portable transfer devices of the present invention, depicting a mounting bracket and quick release pin;

FIG. **79** is a top perspective view of another portable transfer device of the present invention;

FIG. **80** is a top perspective view of a detachable remote control for any of the portable transfer devices of the present invention;

FIG. **81** is a fragmentary top perspective view of a portable transfer device of the present invention, depicting a clip for securing the jaws therein;

FIG. **82** is a fragmentary top perspective view of a portable transfer device of the present invention, depicting a lock-down device for securing the jaws thereto;

FIG. **83** is a top plan view of a portable transfer device of the present invention, depicting the downwardly opening jaw portion of the clamp thereto;

FIG. **84** is a side plan view of a portable transfer device of the present invention, depicting an upwardly opening jaw portion thereof;

FIG. **85** is a top plan view of a motor and winch system, suitable for any of the transfer devices of the present invention;

FIG. **86** is an exploded view of the motor and winch assembly of FIG. **85**;

FIG. **87** is a top front perspective view of a transfer bridge spanning a gap between a bed with a patient reclining thereon and a transfer cart;

FIG. **88** is a bottom plan view of an alternate embodiment of the transfer bridge of FIG. **87**;

FIG. **89** is a fragmentary side view of the transfer bridge of FIG. **87** or FIG. **88**, depicting the hinge thereon;

FIG. **90** is a top front perspective of the bridge of FIG. **87** being folded and prepared for either transport or storage;

FIG. **91** is an exploded view of a clamp of the present invention;

FIG. **92** is a top perspective view of the assembled clamp of FIG. **91**;

FIG. **93** is a side perspective view of a portable transfer unit;

FIG. **94** is a side plan view of the portable transfer unit of FIG. **93**;

FIG. **95** depicts an attendant carrying a portable transfer unit;

FIG. **96** is an elevated left perspective view of the patient transfer system of the present invention;

FIG. **97** is an elevated left perspective view thereof;

FIG. **98** is an exploded view of the top frame of the present invention;

FIG. **99** is an exploded view of the base assembly thereof;

FIG. **100** is a left elevated perspective view of the remote switch of the patient transfer system of FIG. **96**;

FIG. **101** is an exploded view depicting the components of the switch of FIG. **100**;

FIG. **102** is an elevated perspective view of a transfer rod of the present invention;

FIG. **103** is an exploded view of the transfer rod of FIG. **102**;

FIG. **104** is a fragmentary elevated perspective view depicting how the elastic cord is secured to the cord plate of the transfer rod of FIG. **102**;

FIG. **105** is a top plan view of the transport rod of FIG. **102** being disassembled for storage or transport;

FIG. **106** is a top plan view of the transfer rod of FIG. **105** partially disassembled;

FIG. **107** is a side plan view of the transfer rod of FIG. **102** disassembled and ready for storage;

FIG. **108** is an elevated perspective view of the transfer bridge of the present invention;

FIG. **109** is a cross section taken along lines **109**—**109** of FIG. **108**;

FIG. **110** is a side plan view depicting the transfer bridge of FIG. **108** being folded for storage or transport;

FIG. **111** is a side plan view of the transfer bridge of FIG. **108** being completely folded and ready for storage or transport;

FIG. **112** is a side plan view of the patient transfer system of FIG. **96** depicting the transfer rod and the transfer bridge in storage positions;

FIG. **113** is a side plan view of the patient transfer system of FIG. **96** depicting vertical adjustment of the head assembly;

FIG. **114** is a fragmentary elevated perspective view of the head assembly of the lateral patient transfer system with the upper shield removed;

FIG. **115** is a fragmentary side view of the head assembly of the lateral patient transfer system depicting a patient transfer in progress;

FIG. **116** is a fragmentary side plan view of the patient transfer system depicting completion of a patient transfer event;

FIG. **117** is a fragmentary elevated perspective view of the webbing attached to the drum of the head assembly and extending through a slot therefor in the top frame and upper shield and further depicting an interlock switch in place thereto;

FIG. **118** is a top plan view of a webbing attached to the drum of the transfer system of FIG. **96**;

FIG. **119** is a fragmentary elevated perspective view of the transfer hook, joint connector, and webbing of the present invention;

FIG. **120** is a side plan view of the hook, joint connector, and webbing of FIG. **119**;

FIG. **121** is a fragmentary elevated right perspective view of the base assembly of the present invention depicting attachment of the cable to the peddle and actuator assembly thereof;

FIGS. **122–132** sequentially depict a patient transfer event by an attendant using the patient transfer system of the present invention;

FIG. **133** is a fragmentary elevated left perspective view of a transfer hook emplaced over an enwrapped transfer bar of the present invention;

FIG. **134** is a diagram of the electrical and switching system of the present invention;

FIG. **135** is an elevated perspective view of another embodiment of the patient transfer system of FIG. **96**, with extended bumpers;

FIG. **136** is a top plan view of a pair of sheet grippers alternately used with the patient transfer system of FIGS. **96** and **135**;

FIG. **137** is an elevated left perspective view of an alternate embodiment of the patient transfer system of FIG. **96**;

FIG. **138** is an elevated rear perspective view of another alternate embodiment of the patient transfer system of FIG. **96**;

FIG. **139** is a fragmentary perspective view of a stabilizing weight being positioned on a bumper of the transfer caddy of FIG. **96**;

FIG. **140** is a fragmentary elevated perspective view of the transfer caddy of FIG. **139** with the weight in place;

FIG. **141** is a side view of the transfer caddy of FIG. **140**;

FIG. **142** is a bottom plan view of another embodiment of a stabilizing weigh to be installed on the transfer caddy of FIG. **96**;

FIG. **143** is a front exploded view depicting placement of the weight of FIG. **142**;

FIG. **144** is a side view depicting the weight of FIG. **142** installed on the transfer caddy of FIG. **96**;

FIG. **145** is a top plan view of a first embodiment of a transfer sheet cooperating with a plurality of attaching members to form pockets;

FIG. **146** is a top plan view of a second embodiment of the sheet of FIG. **145**;

FIG. **147** is a top plan view of a third embodiment of the sheet of FIG. **145**;

FIG. **148** is a fragmentary perspective view of the sheet of FIG. **145** with a repositioning bar being inserted therein;

FIG. **149** is a fragmentary perspective view of the sheet of FIG. **145** with a repositioning bar in place;

FIG. **150** is fragmentary perspective view of the sheet of FIG. **145** with a repositioning bar inserted and with a transfer hook being attached thereto;

FIG. **151** is a fragmentary perspective view of a first embodiment of another sheet of this invention;

FIG. **152** is a fragmentary perspective view of a second embodiment of the sheet of FIG. **151**;

FIG. **153** is a fragmentary perspective view of a third embodiment of the sheet of FIG. **151**;

FIG. **154** is a fragmentary perspective view of a fourth embodiment of the sheet of FIG. **151**;

FIG. **155** is a fragmentary perspective view of a transfer hook being connected to the sheet of FIG. **154**;

FIG. **156** is a top plan view of a transfer and repositioning sheet of this invention;

FIG. **157** is a sectional view of the sheet of FIG. **156** taken along line **157—157**;

FIG. **158** is a top plan view of a drawsheet layer of the sheet of FIG. **156**;

FIG. **159** is a sectional view of an alternate embodiment of the sheet of FIG. **156**;

FIG. **160** is a fragmentary perspective view of another embodiment of a transfer and repositioning sheet of this invention;

FIG. **161** is a top plan view of the sheet of FIG. **160**;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention includes improved devices and methods for moving and repositioning patients and other individuals who lack full mobility. Patients must be moved in a variety of ways in health care facilities such as hospitals, nursing homes and other residences. For example, patients may need to be transferred horizontally between a bed and a cart, they may need to be repositioned in a bed or chair, or they may need to assume a prone, sitting or standing position. The unifying feature of the various embodiments of this invention is enabling empowering a single health care worker to move a patient in a substantially low risk manner to either the patient or the healthcare worker. The embodiments of this invention further allow a patient transfer event to require between about 20 seconds and 28 seconds and preferably about 24 seconds.

A feature of the horizontal transfer systems of the present invention includes a support beneath the patient and a mechanical or electromechanical system for applying a horizontal force to the support to effect the transfer. The designs of the various embodiments incorporate varying features to achieve this utility. In order to reduce cost, the simplest systems are designed to be adapted for use with beds, carts and transfer sheets now commonly in use in health care facilities. Other embodiments optimize the particular characteristics of the design with less regard to adaptation to existing equipment. In all cases, each design focuses toward the goal of a safe and efficient ergonomic patient transfer event by a single health care worker. Each design also focuses toward greatly reducing the number of healthcare workers required for each transfer event.

This is a continuation-in-part of U.S. patent application Ser. No. 08/713,412, filed Sep. 13, 1996, which is a continuation-in-part of U.S. patent application Ser. No. 08/527,519, now U.S. Pat. No. 5,737,781. The embodiments

of the present invention described hereinbelow are also disclosed in U.S. Provisional Application Ser. No. 60/023,572, filed Aug. 19, 1996, in U.S. Provisional Application Ser. No. 60/025,084, filed Aug. 30, 1996, and U.S. Provisional Application No. 60/043,208, filed Apr. 8, 1997, the entire contents of each being hereby incorporated by reference.

Referring to FIG. **1**, the first exemplary embodiment of horizontal transfer system **100** includes standard patient cart **102** retrofitted with horizontal transfer mechanism **104**. Cart **102** will generally have base **106** with four wheels **108**. Wheels **108** preferably have lock levers **110** for applying brakes to prevent rotation of wheels **108**. Base **106** may have a top surface **112** that usually, but not necessarily, will have a flat portion **114**.

Cart **102** includes support portion **116**. Support portion **116** is attached to base **106** by one or more upright supports **118**. The exemplary embodiment represented in FIG. **1** has two upright supports **118**. Some designs may have wheels **108** attached directly to upright supports **118**, thereby eliminating the need for base **106**. Support portion **116** will preferably include cushioned bumpers **120**. Cart **102** may have the capability of raising and lowering support portion **116** relative to base **106**, as well as other features. Support portion **116** provides support structure **122** for supporting cushion (or mattress) **124** for holding patient **126**.

Exemplary horizontal transfer mechanism **104** includes two side rails **128**. Referring to FIG. **5**, side rails **128** are mounted to cart **102** by hinges **130, 131**. Side rails **128** and hinges **130, 131** are preferably adapted from existing side rails and hinges on cart **102**. Hinges **130, 131** can adjust to place side rails **128** in either an elevated pull position or a lowered storage position as depicted in FIG. **2**. Preferably, hinges **130, 131** are used to place side rails **128** in a horizontal bridge position to provide support and a smooth surface for transferring the patient (FIG. **4**). The different positions are schematically depicted in FIGS. **2–4**. Alternative designs for the side rail may allow for the side rail to slide straight down to a lowered position, although other variations are within the spirit and scope of this invention.

Referring to FIG. **6**, each exemplary side rail **128** includes handle **132**, control panel **134** and a plurality of openings **136** for a power assembly, such as winch **138**. Other openings may be used for access to the winch unit. Control panel **134** has a plurality of switches **140** to control the operation of winch **138**. The particular design of side rail **128** and control panel **134** may be varied without effecting their function.

Referring to FIG. **6**, a convenient structure for side rail **128** includes frame **142**, winch **138**, front cover **144** and back cover **146**. Frame **142** further includes extensions **148** attached to frame substructure **150** at frame hinge **152**. Frame substructure **150** may include winch mounting portion **154**. Frame substructure **150** may be made from metal, a rigid polymer or a composite material, although other materials exhibiting the proper strength, weight, and cost characteristics may be suitable. Back cover **146** may define open portions **156** and handle **132**. In this example, extensions **148** are disposed through open portion **156**. Moreover, the sizes and configurations of open portions **156** admit frame hinges **152**. Open portions **152** are further dimensioned to admit coincident movement when side rail **128** is raised or lowered by pivoting side rail **128** on hinges **152**. Outer surface **147** of back cover **146** (FIG. **5**) is a transfer surface which may include a low friction material to assist with the transfer process and reduce the risk of injury. Front cover **144** includes a mated part of handle **132**. Front cover **144** further defines openings **136** and control panel opening **158**.

Winch **138** is coupled to control panel **134** by wires **160**. A conventional manual winch may also be used without excess difficulty, but less conveniently. Drive system **143** may include at least one motor **162**. Both drive system **143** and motor **162** may be configured in a variety of conventional designs. Motor **162** may directly rotate drive shaft **164** as depicted in FIG. **6**. In the embodiment of FIG. **7**, motor **162** rotates first drive shaft **165**, thereby rotating first gear **166**. First gear **166** engages second gear **168**. Second gear **168** is connected to second drive shaft **170**. Second gear **168** may have a larger diameter than first gear **166**, thereby causing a reduced rate of rotation of second drive shaft **170** relative to first draft shaft **165**.

Two belts **172** each with a clip **174** are attached to second drive shaft **170** at positions coincident openings **136**. Belts **172** preferably wind on spools **175**. Spools **175** help ensure that belts **172** wind and unwind straight. Belts **172** are preferably made from very strong synthetic fabric such as the material used in seat belts for automobiles. Winch **138** may be powered by a battery pack **176**. Winch **138** and battery pack **176** are electrically connected by power cord **178**. Alternatively, winch **138** may be powered by alternating current using another power cord (not shown). Cart **102**, or any other embodiment of the present invention, may also include aligning and docking mechanisms. Aligning mechanisms may further include powering and steering means, whereby at least two wheels **108** of cart **102** are powered and steered by operation of control switches **140**. Docking mechanisms may include clamps and electromagnets. These clamps and electromagnets may also be operated by control switches **140**. These clamps and electromagnets may secure cart **102** to the horizontal surface onto which the patient is to be transferred.

In addition to control switches **140**, hand-held remote control units communicating with the control mechanism of cart **102** by electric or electromagnetic means are within the scope of the present invention. Voice actuated controls are also within the scope of the present invention, thereby enabling the patient, as well as an attendant, to begin and discontinue a transfer event.

Cart **102**, or any other embodiment of the present invention, may further include means for sensing an asynchronous operation of the transfer mechanisms. Such means include sensing the individual belt torque or drag experienced when belts **172** are being retracted and a comparison of these sensings. A difference between sensings exceeding a predetermined value or a sensing ratio greater than or less than a predetermined ratio range would result in an alarm being actuated or an automatic discontinuance of transfer.

Cart **102** of FIG. **1** is designed for use with standard patient draw sheet **190**. Standard patient draw sheet **190** is sufficiently wide that it can be folded over patient **126** if desired. Typically draw sheet **190** is not long enough that it extends under the head or feet of the patient. Rather than using several persons to move the patient disposed on draw sheet **190**, horizontal transfer mechanism **104** performs a comparable function. Clips **174** are designed to attach directly to draw sheet **190**. However, a worker may also use another clamping device to provide a more even pull over more of the length of sheet **190** and thus provide a smoother transfer motion to the patient. For particularly tall patients, draw sheet **190** may be wrapped around patient **126** for added support. Both ends of draw sheet **190** are then attached to the clamping device.

Three embodiments of exemplary clamping device **194** are presented in FIGS. **8–13**. The first embodiment of clamping device **194** is shown in FIGS. **8** and **9**. Clamping device **194** may be used to attach draw sheet **190** to winch **138**. Clamping device **194** may employ rod **192** in doing so. A cross section of clamp **196** includes U-shaped portion **196**, which forms cavity **198**. Cavity **198**, in turn, is covered by spring loaded gate **200**. Rod **192** can enter cavity **198** when pushed against gate **200**. Force from rod **192** against gate **200** from inside cavity **198** tends to force gate **200** closed, thereby further preventing withdrawal of rod **192**. Gate **200** includes upward extension **202**. Forward force on upward extension **202** opens gate **200** for the withdrawal of rod **192** from cavity **198**. Clips **174** are conveniently attached to clamping device **194** at J-shaped flanges **204**. Rod **192** can be optionally tethered to the clamping device **194** at one or more positions. Rod **192** may also be clipped to clamping device **194** for storage.

In the second and third embodiments, clamping device **194** includes upper portion **206** and lower portion **208** attached at hinge **210**, thereby defining cavity **212**. The front of cavity **212** is closed by L-shaped, hinged closure **214**. The two embodiments to device **194** differ in their design for J-shaped flanges **216**, **218** for attaching clips **174**. In these embodiments, sheet **190** is directly placed into cavity **212** without the need to wrap sheet **190** around rod **192**. However, rod **192** could still be used if desired. Sheet **190** is held in place by L-shaped hinge closure **214**. A thin rigid tucking device (not shown) of any convenient length may be used if desired to assist with tucking sheet **190** into clamp **194**.

Clearly, a variety of other designs for clamping device **194** are possible within the general concepts presented. In each of these embodiments, any portion of sheet **190** may be attached, not just the edge of sheet **190**. This is an important feature because clamping device **194** should preferably be placed as near as possible to the patient so that transfer mechanism **104** can fully transfer the patient from the first horizontal surface to the second.

In operation, cart **102** is wheeled to a patient's bed **220**, as depicted in FIG. **1**, or onto another cart. Side rail **128** facing bed **220** is placed in the bridge position with low friction surface **147** directed upward. Draw sheet **190** is attached to a clamping device. Belts **172** are unwound from drive shafts **164** or **170** until they reach rod **192** at the edge of bed **220**. Belts **172** are unwound either by activating motor **162** to unwind them or by using a clutch (not shown) to allow belts **172** to be freely withdrawn from the drive shaft. Clips **174** on the ends of belts **172** are attached to exemplary clamping device **194**. Clamping device **194** is then engaged by rod **192** and sheet **190**. Other embodiments of clamping device **194** may be used with or without rod **192**.

After the appropriate switch mechanism **140** is actuated, winch **138** begins winding belts **172** onto drive shafts **164** (FIG. **6**) or spool **175** (FIG. **7**). Motor **162** may be designed to apply a slow, steady and constant force to move patient **126** without jerking. Motor **162** may further advantageously provide variable speeds of movement consistent with gradual starts and stops and safe transfer throughout the length of travel. Draw sheet **190** helps to distribute transfer forces over significant areas of the patient's body. When patient **126** is on cart cushion **124**, motor **162** is turned off or otherwise disengaged. At this point, belts **172** are disconnected from clamping device **194**. Sheet **190** is then removed from clamping device **194**.

To transfer a patient from a cart to a bed, the bed should be equipped with a winch such as winch **138** present on cart **102**. This bed-based transfer device may include the side rails of a conventional bed. These side rails typically slide vertically rather than folding under the bed. Winch **138** could easily be adapted on one or both sides of the bed, and may be retrofitted to a bed in a comparable fashion as with cart **102**, based on the above description.

Alternatively, a portable winch unit readily carried by a single health care provider may be used to replace winch **138** on bed **220**, or cart **102**. Exemplary portable winch unit **250** is shown in FIGS. **14–16**. Portable winch unit **250** includes housing **252**, clamping device **254** and winch **256**. Clamping device **254** may hold and grip transfer sheet **190** in a similar manner as clamping device **194**. Clamping device **254** also serves as a frame or a portion of a frame for the portable winch unit **250**. Housing **252** preferably includes top portion **258** and bottom portion **260**. Top portion **258** and bottom portion **260** may be heavy plastic shells surrounding clamping device **254** and winch **256**.

Winch **256** includes motor **262**. In operation motor **262** rotates a drive shaft (not shown) on which reel **263** is mounted. Belt **264** winds around reel **263**. Belt **264** is comparable to belts **172** in embodiment **100**. Handle **266** attaches to a free end of belt **264**. Handle **266**, in turn, attaches to clamp **268**. Clamp **268** attaches to the edge of a bed or cart. Clamp **268** may be designed to fold out of the way when not in use. Belt **264** passes out of housing **252** through opening **270**. The operation of winch **256** may be controlled through circuit board **272**. Circuit board **272** may electrically connect to motor **262** by means of wire **274**. Circuit board **272** may be electrically connected to port **276**.

Control unit **278** with switches **280** may be electrically connected to port **276** by way of tether **282**. The operator may operate winch **256** using control unit **278**. Alternatively, control switches **280** may be present within housing **252**, as shown in FIG. **15**. However, this may be less desirable because the operator would need to lean over the bed or cart while the patient was being transferred. Control unit **278** may also have a wireless connection with circuit board **272** using a transmitter/receiver (not shown). Winch **256** may be powered by a standard wall outlet using cord **284**. Retractable cord assembly **286** may be used to retract cord **284** when cord **284** is not in use. Retractable cord assembly **286** may also be used to prevent excess cord from being in the way during a patient transfer. Alternatively, a battery, preferably rechargeable, may be used to power winch **256**.

As shown in FIG. **14**, a patient may be transferred from a first bed/cart **288** to a second bed/cart **290**. Draw sheet **190** may be disposed under the patient in a similar manner as described above with respect to embodiment **100**. FIG. **17** depicts portable cushion **292**. Cushion **292** may be placed between the first bed/cart **288** and the second bed/cart **290** to provide a relatively smooth continuous surface for transferring the patient. Mating portions of a hook and loop fastener are present on a surface of portable cushion **292** and the bed or cart. Thus, portable cushion **292** may be attached to the bed or cart when not in use. Portable cushion **292** may also be used with other transfer devices or as an aid during a manual transfer. A top surface of cushion **292** may include a very low friction material. The very low friction material may be plastic.

Portable winch unit **250** may be attached to draw sheet **190** by means of clamping device **254**, (FIGS. **15**, **16**). The design of clamping device **254** may be similar to the clamping devices in FIGS. **8–13** or a comparable design based on similar concepts. Draw sheet **190** may be wrapped about rod **192** (FIG. **8**) for attachment to clamping device

254. Referring to FIG. 14, belt 264 is withdrawn from housing 252 so that handle 266 can be attached to clamp 268. Clamp 268 is rigidly attached to second bed/cart 290 on its side opposite the side near first bed/cart 288. Clamp 268 can be optionally reversibly detachable or lowerable to a storage position. The operator uses control unit 278 to activate motor 262. As motor 262 retracts belt 264, portable winch unit 250 and the patient are drawn toward clamp 268 which result in the patient being moved onto second bed/cart 290.

Referring to FIG. 14, the transfer devices of the present invention, especially the clamps, are designed to be centered at the patient's center of gravity when the patient is in a supine position. A patient's center of gravity is usually about midway between the patient's navel and buttocks, represented as lines N and B, respectively. Thus, to move the patient smoothly and evenly, the clamp center of gravity (represented by arrow C) should be aligned about midway between lines N and B on the patient.

Exemplary horizontal transfer system 300 includes an especially designed transfer sheet 302 and transfer unit 304, as shown in FIG. 18. Transfer unit 304 can move a patient in either of two directions. Thus, horizontal transfer system 300 has the advantage that only the cart or bed, but not both, must be equipped with transfer unit 304. Therefore, the cart or bed not adapted by transfer unit 304 may be conventional in design.

Transfer unit 304 includes head frame 306 and foot frame 308. Head frame 306 and foot frame 308 are in mechanical communication with drive system 310 (FIG. 19). Head frame 306 replaces or attaches to the head board of the bed or cart. Foot frame 308 replaces or is attached to the foot board of the bed or cart. Head frame 306 and foot frame 308 include at least one vertical support 312. A bottom portion of vertical support 312 may include wheel 314. Wheels 314 are oriented to roll in a direction defined by the width of the bed/cart. Wheels 314 may be attached to vertical support 312 in such a manner that wheels 314 are shifted up and out of contact with the floor. Thus, the bed or cart may then be moved more easily because wheels 314 are retracted away from the floor. Vertical supports 312 may have a removable brace (not shown) extending therebetween. When in use, the removable braces serve to enable vertical supports 312 to become more rigid by compensating for forces created by the weight of the patient during transport.

Referring to FIGS. 19–21, head frame 306 and foot frame 308 each include at least one expandable horizontal support 316 and lifting support 324. Each horizontal support 316 extends from vertical supports 312. Horizontal supports 316 include fixed portions 318 and telescoping portions 322. Fixed portions 318 are attached to the head board, foot board, head board portion 320, or foot board portion 320. Fixed portions 318 may extend at least across the width of the bed or cart. Telescoping portions 322 are attached to each vertical support 312 and slidably engage a corresponding fixed portion 318. In certain embodiments, telescoping portion 322 will slide into a corresponding fixed portion 318, although other types of slidable engagement are possible.

Lifting support 324 slidably attaches to fixed portion 318 such that lifting support 324 moves with vertical support 312 and telescoping portions 322. Each lifting support 324 includes gripping portion 328 and two lifting portions 330. Gripping portion 328 may define opening 332. Sheet clamp 325 will be discussed in more detail hereinbelow. However, first ends of cables 327 may extend from sheet clamp 325 through opening 332. Second ends of cables 327 may be secured to gripping portion 328. Thus, raising lifting support 324 will also raise clamp 325. Referring to FIG. 23, cables 327 permit sheet clamps 325 to remain attached to transfer sheet 302 while mattress support 329 goes through a range of motion. In one configuration, first lifting portion 330 engages vertical support 312 at slot 336. Second lifting portion 330 engages moving support 338 which is attached to telescoping portion 322.

Exemplary lifting support 324 is capable of a range of vertical motion. The range of vertical motion enabled by lifting support 324 will typically be between 6" and 12". This range of vertical motion provides sufficient clearance for a horizontal transfer from a first bed/cart to a second bed/cart. Thus, retrofitted bed/cart 326 with attached transfer unit 304 can transfer patients from or to retrofitted bed/cart 326. Lifting support 324 also enables workers to change linen more conveniently. However, transfer sheet 302 needs to be changed separately.

Referring to FIG. 19, drive system 310 includes horizontal drive system 340 and vertical drive system 342. Drive system 310 is operated from control panel 344 (FIGS. 18–20). Control panel 344 may be located on vertical supports 312. Alternatively, portable controller 345 (FIG. 23) is patched into head frame 306 or foot frame 308 through connector 348. Other embodiments for controlling drive system 310 are possible. Drive 342 enables vertical motion of lifting support 324. Drive 342 may be adapted to operate by motorized worm drive 343 or by other motor or hydraulic systems.

Two embodiments are shown for horizontal drive system 340 in FIGS. 19 and 21, respectively. The first embodiment includes motor 350. Motor 350 is secured to the frame of bed/cart frame 352. Motor 350 turns drive shafts 352, 354. Drive shafts 352, 354 connect to transmission 356. Transmission 356, in turn, is in mechanical communication with telescoping portion 322. Thus, actuating motor 350 results in extending or retracting telescoping portion 322 within fixed portion 318.

The second embodiment of drive system 340 includes motor 358 mounted on either head frame 306 or foot frame 308. Motor 358 rotates worm drive 360. Worm drive 360 is mounted horizontally alongside motor 358. Worm drive 360 transfers motion from motor 358 to telescoping portion 322. Optional removable panel 362 can be removed, as shown in FIG. 24, and mounted on foot frame 308. When mounted on foot frame 308, panel 362 may be used as a shelf, as a cardiopulmonary resuscitation (CPR) board, or to support additional equipment as shown in FIG. 25.

An appropriate transfer sheet 302 for use in this embodiment of horizontal transfer unit 300 is depicted in FIGS. 27 and 28. Transfer sheet 302 includes wings 380. Hook and loop or comparable fasteners 382 may be present on the edges of wings 380. Wings 380 may be folded over the patient and closed with fasteners 382. The shape of wings 380 may be selected as desired. The top and bottom of transfer sheet 302 may include reinforced attachment portions 384. Reinforced holes, grommets 334, or other improved attachment means are optionally present within reinforced portions 384. Sheet 302 may be attached to sheet clamps 325. Alternatively, sheet 302 may be attached to the clamps shown in FIGS. 8–13. The presence of grommets on sheet 302 may be a disadvantage when sheet 302 is being laundered. Attachment portions 384 will generally extend to or just beyond the end of the mattress 386. Other designs are possible for sheet 302, for example an embodiment which does not fold over the patient.

As depicted in FIGS. **19** and **20**, vertical supports **312** and telescoping portion **322** are initially placed in a retracted position if the patient is being moved from retrofitted bed/cart **326**. Vertical supports **312** and telescoping portion **322** are initially placed in their extended position if the patient is being moved from a separate bed/cart **331** to retrofitted bed/cart **326**. Transfer sheet **302** is optionally folded over the patient, and fasteners **382** are secured together. Attachment portions **384** are placed into opening **332** and sheet clamps **325** engage reinforced holes **334**. At this point, vertical drive system **342**, originally in its lower point, is engaged to extend to its upper point, thereby raising the patient into a suspended position.

Horizontal transfer system **300** is engaged accordingly to move the patient from an original location to the transfer location. If the patient was originally disposed on retrofitted bed/cart **326**, vertical supports **312** and telescoping portion **322** are moved to extended positions. If the patient was not originally located on the retrofitted bed/cart **326**, vertical supports **312** and telescoping portion **322** are moved to retracted positions. Once the horizontal transfer is complete, vertical drive system **342** is lowered and transfer sheet **302** is disengaged therefrom.

Another embodiment of a patient transfer device **400** is shown in FIG. **29**. Head portion **402** and foot portion **404** may be similar in construction to head frame **304** and foot frame **306**, respectively. However, head portion **402** and foot portion **404** lack lifting supports **324** attached to telescoping portion **320**. Head portion **402** and foot portion **404** instead include top supports **406**. Top supports **406** support upper transverse support **408**. Upper transverse support **408** provides support to counterforces resulting from the weight of the patient during a transfer.

Upper transverse support **408** may include transverse tracks **410** on both sides thereof. Transverse tracks **410** support lifting elements **412**. Lifting elements **412** include track wheels **414**. Track wheels **414** rotate within tracks **410**, thereby enabling lifting elements **412** to transverse thereon. Lifting elements **412** may include winches (not shown) to retract cords **416**. Cords **416** may have fasteners **418** at their ends for attaching to reinforced holes or grommets **420** at the corners of draw sheet **422**. Retracting cords **416** raise draw sheet **422**, on which the patient is secured therewithin.

As shown in FIG. **30**, extendable horizontal supports **424** may include wheels **428**. Horizontal supports **424** enable lateral motion of vertical supports **426**, along with upper transverse support **408** and lifting elements **412**. As with system **300**, device **400** can transfer a patient from a retrofitted bed/cart to a second bed/cart or from a second bed/cart to the retrofitted bed/cart.

An exemplary single lifting element **412** is depicted in FIGS. **31, 32**. Element **412** may be used with lift jacket **430**. Lift jacket **430** fits around the torso of a patient and includes loops **432**. Fasteners **418** attach to loops **432**. When thusly attached to lift jacket **430**, cords **416** may be retracted, thereby lifting the patient's torso off the bed and into a bent position at the patient's waist. Lifting element **412** may then be translated and rotated as shown in FIGS. **31** and **32**, thereby placing the patient in a seated position at the side of the bed. The patient's back is supported in this position. In this way horizontal transfer device **400** serves a second purpose in assisting a patient from a supine to a sitting position.

Exemplary transfer system **500** is depicted in FIG. **33**. Transfer system **500** is designed for retrofitting both bed **502** and cart **504**. Transfer system **500** includes horizontal transfer mechanism **508** and transfer bridge **510** (FIGS. **37–41**). Horizontal transfer mechanism **508** includes docking mechanism **506**. FIGS. **34** and **35** depict two representative embodiments of docking mechanism **506**. Bed **502** of the first embodiment includes foot board **518**. An opening **516** is defined in the side of foot board **518**. The first embodiment of transfer system **500** includes spring loaded clamp **512**. Clamp **512** includes arms **514**, each arm **514** with an angled front edge **524**. Arms **514** protrude from opening **516** at side of foot board **518** of bed **502**. Spring loaded clamp **512** engages cavity **520**, which opens into transfer bar **522**. When angled front edge **524** of arms **514** engage cavity **520**, arms **514** resiliently deflect towards each other until tips **526** clear flanges **528**. When tips **526** clear flanges **528**, arms **514** return outwardly as tips **526** engage flanges **528**. Arms **514** pivot on docking support **530** within bed foot board **518**. Head boards (not shown) of bed **502** and cart **504** have a comparable docking mechanism. When clamp **512** is protruding from opening **516**, arms **514** may be disengaged by being pressed together.

The second embodiment of the docking mechanism **506** is depicted in FIG. **35**. In this second embodiment, gear **538** is supported by a docking support **540**. Gear **538** protrudes from opening **542** in the side of bed foot board **544**. Protruding gear **538** engages teeth **548**, which are disposed on top surface **550** of cavity **552** within transfer bar **522**. Gear **538** may flex slightly on its support **540** to engage teeth **548**. Cavity **552** within transfer bar **522** may not have flanges at its opening. Gear **538** is disengaged by pressing downwardly on docking support **540** when docking support **540** is protruding from opening **542**. The head boards (not shown) of bed **502** and cart **504** may have a comparable docking mechanism.

The two embodiments of docking mechanisms **506** are described in a particular configuration with respect to the cart and the bed. This configuration may be reversed with the bed containing protruding gear **532** or clamp **512**. In either configuration, the protruding gear or clamp may be retracted by worm gear drive **532** during a docking.

Horizontal transfer mechanism **508** is shown in FIG. **36**. Transfer mechanism **508** includes transfer element **556** and drive system **558**. Transfer element **556** includes gripping mechanism **560** and transfer bar **522**. Gripping mechanism **560** grips transfer sheets such as transfer sheet **302**. Gripping mechanism **560** is attached to transfer bar **522** by a plurality of support bars **564**. Gripping mechanism **560** may be similar to sheet clamp **325**. Transfer bar **522** slides within cart channel **566** and bed channel **568**. Cart channel **566** and bed channel **568** respectively define slots **570, 572**. Support bars **564** extend through slots **570, 572** within cart channel **566** and bed channel **568**, respectively. Docking supports **530** or **540** may be moved laterally by drive system **558** which may comprise worm gear drive **532** (FIGS. **34, 35**). Worm gear drive **532** includes motor **534** and worm **536**. Rotating worm **536** laterally moves docking supports **530** or **540**. The motion of the docking supports **530** or **540** moves transfer bar **522** within channels **566** and **568** (FIG. **28**). Worm gear drive **532** can move the transfer bar **522** in either direction, thereby effecting a patient transfer in either direction.

Transfer bridge **510** is mounted on the side of cart **504** (FIGS. **37, 41**). Transfer bridge **510** includes bridge **574**, lever **576** and mounting portions **578**. Bridge **574** is preferably molded from a low friction material such as, for example, polypropylene, to facilitate passage of the transfer sheet. It is recognized that other low friction materials may also be suitable. Mounting portions **578** are attached to the

side of cart **504** by rods **580**. Mounting portions **578** include hinge **582** which supports bridge **574**. Lever **576** passes through mounting portions **578**. Rotating lever **576** changes the configuration of hinges **582**, thereby moving bridge **510** between a stored position and a bridge position, as shown in FIGS. **37–40**. In the bridge position, bridge **574** fills in the gaps between bed **502** and cart **504**. In the storage position, bridge **574** may function as a side rail for cart **504**. FIG. **41** depicts a different embodiment of transfer bridge **510**, including split transfer bridge portions **584**. These embodiments of the transfer bridge may be adapted for use with other transfer systems including the conventional manual transfer system.

To transfer a patient between bed **502** and cart **504**, transfer sheet **302** is attached to gripping mechanisms **560** proximate the patient's head and foot, in a similar manner to the attachment of transfer sheet **302** in the embodiment of FIG. **18**. Referring to FIG. **36**, cart **504** and bed **502** are positioned to align channels **566** and **568**. Referring to FIG. **38**, transfer bridge **510** is placed in its transfer position to fill the gap between bed **502** and cart **504**. As shown in FIG. **36**, drive system **558** is engaged to move transfer element **556** from bed **502** or cart **504** where the patient was located to the bed **502** or cart **504** to which the patient is being transferred. Once the patient is transferred, cart **504** and bed **502** are undocked, and transfer sheet **302** is disconnected from gripping mechanisms **560**.

The above transfer systems rely on supporting the patient on some type of sheet during the transfer. However, present methods often rely on health care personnel to provide the necessary transfer forces, usually by pulling a transfer sheet. However, supporting the patient on a sheet may be inappropriate for patients with certain injuries. Hence, it may be safer to transfer the entire mattress or cushion, as described below.

FIG. **42** depicts exemplary bed **600**. Bed **600** includes exemplary mattress transfer system **602**. Bed **600** supports modular mattress **604** and fixed cushion **606**. Modular mattress **604** includes wing **608** made of padded fabric in this example. Wing **608** wraps around fixed cushion **606** to form a smooth surface without gaps, as shown in the insert to FIG. **42**. Wing **608** tucks under modular mattress **604** when not in use. Referring to FIG. **43**, bed **600** connects to cart **610** by way of docking mechanism **612** when mattress **604** is to be transferred. Docking mechanism **612** includes one or more apertures **614** for accepting projections **616**. FIG. **43** displays apertures **614** on bed **600** and projections **616** on cart **610**. However, the opposite arrangement would work similarly. It is possible to provide a locking mechanism (not shown) to lock projections **616** within apertures **614**. The locking mechanism would prevent relative motion of bed **600** and cart **610** during transfer of modular mattress **604**. However, the same effect may be accomplished by locking the wheels of cart **610**.

In one embodiment, mattress transfer system **602** includes transverse bar **618**, a plurality of lateral bars **620** and at least one lateral drive bar **622**. Transverse bar **618** is connected to the plurality of lateral bars **620** and to at least one lateral drive bar **622**. Lateral bars **620** slide along lateral tracks **624**. Lateral drive bar **620** engages lateral drive track **626**. Lateral bars **620** and lateral drive bars **622** allow transverse bar **618** to extend just past the edge of bed **600**. Transverse bar **618** has a plurality of gripping mechanisms **628**. Each gripping mechanism **628** may assume a pushing position (FIG. **44**) and a pulling position (FIG. **45**) for respectively pulling and pushing modular mattress **604**.

Referring to FIGS. **42** and **46**, gripping mechanisms **628** grip handles **630** near the edge of modular mattress **604**. Mattress transfer system **602** is controlled from control panel **632** mounted on foot board **634**, as shown in FIG. **42**. Actuating mattress transfer system **602** moves transverse bar **618** either toward or away from cart **610** by moving lateral drive bar **622** accordingly. Of course, a variety of designs are possible for the mattress transfer system **602** besides the embodiment described.

Referring again to FIG. **46**, modular mattress **604** may include channel system **636** to accommodate transfer system **602**. Channel system **636** includes transverse void **638** and longitudinal channels **640**. Transverse void **638** accommodates transverse bar **618**. Longitudinal channels **640** accommodate lateral tracks **624** and lateral drive track **626**. Handles **630** are located along an upper surface of transverse void **638**. To the extent necessary, channels **642** may be present within fixed cushion **606**.

In order to transfer modular mattress **604**, cart **610** is first docked with bed **600** using docking mechanism **612**. If modular mattress **604** is being moved to cart **610**, the patient is centered on modular mattress **604**, and gripping mechanisms **628** are set from control panel **632** into a pushing position. Mattress transfer system **602** is then operated to move transverse bar **618** toward cart **610**. When modular mattress **604** is located on cart **610**, docking mechanism **612** is disengaged.

If modular mattress **604** is being moved from cart **610** to bed **600**, cart **610** and bed **600** are docked appropriately. Then, transverse bar **618** is placed into an extended position within transverse void **638**. Gripping mechanisms **628** are placed in their pulling position. Mattress transfer mechanism **602** is operated to move transverse bar **618** away from cart **610**. When modular mattress **604** is in position on bed **600**, mattress transfer system **602** is stopped and docking mechanism **612** is disengaged.

Bed **600** with mattress transfer system **602** may be adapted to cooperate with exemplary position changing cart **650** when used with folding mattress **652**, as shown in FIGS. **47–49**. Position changing cart **650** includes base **654** and a plurality of, preferably two, arms **656**. Base **654** has a plurality of locking wheels **658** to provide a relatively broad base of support for cart **650**. Base **654** should have sufficient weight and a relatively low center of mass such that cart **650** is stable. Top **660** of base **654** provides support for the center of folding mattress **652** when mattress **652** is positioned on cart **650**.

Arms **656** may include support portion **662** and lever portion **664**. Support portions **662** extend laterally toward bed **600** from the far edge of cart **650**. Lever portions **664** are rigidly attached to support portions **662** at one end and are attached to hinge mechanism **666** at base **654**. Support portions **662** support folding mattress **652** when mattress **652** is positioned on cart **650**. A folding drive (not shown) within base **654** is operated from control panel **668** at the side of base **654**. The folding drive operates to rotate hinge mechanisms **666** to change folding mattress **652** from a prone configuration to a seated configuration, or visa versa, as depicted in FIGS. **47,49**.

When going from a supine to a seated configuration, lever portion **664** at the head of mattress **652** rotates upwardly and lever portion **664** at the foot of bed **400** rotates downwardly. Folding mattress **652** may include creases **670** to accommodate changes in configuration. Movement of folding mattress **652** on and off position changing cart **650** is analogous to moving modular mattress **604** on and off cart **610**.

The next devices are designed to hoist, or pull up, a patient disposed on a bed or a chair. These devices are

configured with at least one lifting device and at least one winch system. Exemplary embodiment **700** illustrates a hoist system. Hoist system **700** includes "lobster claw-shaped" bed jacket **702**, as shown in FIGS. **50–52**. Bed jacket **702** has two "claw" portions **704** joined at joint **706**. Claw portions **704** are made of fabric enclosing a padding in one embodiment. Exemplary joint **706** includes folds in the fabric which enable a greater flexibility therein. No portion of bed jacket **702** fits under the mid-torso of a patient. Hence, it is relatively easy to place bed jacket **702** on the patient. Lifting forces generated when bed jacket **702** is used are distributed across the patient's chest and the patient's neck is supported by claw portions **704**.

Claw portions **704** may display edges **708** at their ends opposite joint **706**. Edges **708** may be joined by hook and loop fastener **710**, with clips (not shown), as well as other suitable fasteners. However, edges **708** do not necessarily have to be joined before the patient is moved by bed jacket **702**. In use, joint **706** is placed across the patient's chest and claw portions **704** are placed under the patient's arms. Edges **708** may be joined behind the patient's neck, if desired. If edges **708** are not joined, they will nonetheless be held together by loops **714**. Loops **714**, in turn, are attached to a hoist cable as described below.

Bed jacket **702** may be used with at least two embodiments of the winch system described herein. A first embodiment, winch system **712**, is depicted in FIG. **52**. In this embodiment, bed jacket **702** includes loop **714** for attaching tether **716**. Tether **716** winds on external winch **718**. External winch **718** may be attached to head board **720**, located on support **722**. Support **722** may be in an elevated position above a bed or wheel chair **724** (FIG. **53**) or mounted to a ceiling (FIG. **52**). External winch **718** may be operated manually with a hand crank (not shown) or with a motor (not shown). If present, the motor may be controlled by a control panel.

As shown in FIGS. **54**, **55**, external winch **712** may also be used with padded vest **762**. Exemplary padded vest **762** offers many of the same advantages as lobster claw bed jacket **702**. Padded vest **762** includes foam portion **764** and straps **766**. Foam portion **764** fits across the patient's chest. Two adjustable straps **766** extend from foam portion **764**. One strap **766** includes head support **768** attached thereto. The free end of head support **768** may be attached with hook and loop fastener **770** or a comparable fastener to the other strap **766**. Rings **772** may be attached to the ends of straps **766**. Rings **772** attach vest **762** to tether **716**. Tether **716** is wound about winch **718**.

FIGS. **53**, **56–58** depict exemplary winch system **726**. Winch system **726** includes bed jacket **730**. Winch mechanism **728** is disposed within bed jacket **730**. Winch mechanism **728** is preferably motorized. Winch mechanism **728** is embedded in one of claws **732** of bed jacket **730**. However, winch mechanism **728** may be imbedded in other designs of bed jackets as well. Exemplary winch mechanism **728** includes motor **734**. Motor **734** rotates drive shaft **736**. Spool **738** is mounted on drive shaft **736**. A first end of tether **740** is attached to spool **738**. Ring **742** is attached to the second end of tether **740**.

Claw **732** may also include controls such as release switch **744**, recoil switch **746**, pull switch **748** and lower switch **750**. Release switch **744** releases spool **738**, allowing tether **740** to be unwound therefrom. Recoil switch **746** winds tether **740** on spool **738** using a spring mechanism (not shown) if there is a sufficiently minimal resistance from tether **740**. Pull switch **748** activates motor **734** to wind tether **740** on spool **738**. Lower switch **750** actuates motor **734** in the opposite direction, thereby releasing tether **740** from spool **738**. Optionally, controls **744–750** may be disposed externally to bed jacket **730**. If so, controls **744–750** may be contained within a remote control unit or mounted to a bed. External control units may communicate with winch mechanism **728** either through a wired or wireless (transmitter/receiver) communication in a similar manner to control unit **278** on the clamp embodiments depicted in FIGS. **15** and **16**.

Exemplary ring **742** may be attached to head board **720**, to an elevated support on wheel chair **722** or to ceiling mount **52**. Thus, motorized bed jacket **730** may be used in the same way as its non-motorized counterpart **702**. Winch-bed jacket combination **730** is more versatile because it may be used without separate winches. Furthermore, controls **744–750** are conveniently located. Hence, a health care worker can operate controls **744–750** while being close enough to the patient to assist in the transfer thereof.

Bed jacket **702** may also be connected by way of three axis control cylinder **752** to three ceiling mounted winches **754**, as shown in FIGS. **59** and **60**. Control cylinder **752** may connect to bed jacket **702** by way of ball **756**. Ball **756** fits into ball joint **758**. Control cylinder **760** may include three switches **760**. Each switch **760** controls motion along one of three axes. Referring to FIG. **61**, switches **760** are in electrical communication with microprocessor **753**. Microprocessor **753** may be preprogrammed to include the locations of winches **754** in its memory. Thusly programmed, microprocessor **753** may calculate instructions for winches **754** to perform selected motions. Microprocessor **753** may be connected to winches **754** by way of wires **755**. This versatile system can be used in a variety of ways including transferring a patient from bed **762** to a wheel chair **724** and pulling the patient up in either bed **762** or wheel chair **724**. Padded vest **724** may also be used with three axis control cylinder **752**.

FIGS. **62–95** further relate to features of a portable patient transfer system of the present invention. Each component thereof, is consistent with the patient care and health care injury reduction goals stated above. Referring to FIGS. **62–64**, exemplary engaging mechanism **800** is shown. Engaging mechanism **800** is designed for engaging or clamping a sheet bearing a patient. Engaging mechanism **800** includes forwardly opening element **802**, arcuate engaging element **804**, belt engaging element **806** and cylindrical member **807**. In this embodiment, elements **802**, **804** are elongated and may have a length of at least greater than about 60 cm and preferably at least about 100 cm. Element **802** includes interiorly disposed movable extension **808**. A laterally disposed edge, such as convex edge **810**, is present on extension **808**. Arcuate engaging element **804** displays exterior surface **812** and interior surface **814**. Interior surface **814** defines cavity **816**. A plurality of belt engaging elements **806** are affixed to element **802**. Elements **806** extend through engaging element **804**. At least one engaging slot **817** is defined exterior to engaging element **804** on belt engaging element **806**. Disposed on each end of element **802** is pivot means **818**. Pivoting member **820** is slidingly and rotatingly affixed about pivot means **818**. Pivoting member **820**, in turn, is rigidly affixed to portions of cylindrical member **807**. The exterior surface of cylindrical member **807** may be smooth or may present a roughened surface to enhance gripping. A rubberized or tacky substance may be present on the surface of cylindrical member **807**. Other means to enhance gripping such as an increased surface area or greater gripping features of the existing surface area may also be

present. A plurality of biasing springs or other biasing means (not shown) are optionally and operably disposed within engaging mechanism **800**.

Functionally, elements **802**, **804** of engaging mechanism **800** are biased away from each other by means one or more biasing springs (not shown). When a user desires to place a transfer sheet within engaging mechanism **800**, the user first wraps a portion of the transfer sheet around cylindrical member **807**. Subsequently, cylindrical member **807** is pivoted proximate convex interior surface **810**. Elements **802** and **804** are then forced toward each other, thereby extending engaging slot **817** on belt engaging element **806** away from element **804**. When elements **802**, **804** are in a closed position, cylindrical member **809** and the portion of the transfer sheet wrapped around cylindrical member **809** are enclosed within clamp **800**. Engaging slot **817** is displaced by forcing elements **802**, **804** toward each other. Hence, when elements **802**, **804** contact and grip cylindrical member **809** and the enwrapped transfer sheet, engaging slot **817** is sufficiently distant from element **804** for belt buckle **822** to firmly latch onto belt engaging element **806**. Belt buckles **822**, when firmly attached onto engaging element **806**, thereby hold elements **802** and **804** in a closed position. Elements **802**, **804** enclose cylindrical member **809** therein and exert a gripping force on the portion of the transfer sheet enclosed. When a patient is being transferred, a transfer force is exerted on belt engaging elements **806**, further forcing elements **802** and **804** toward each other and thus exerting an additional, or further, gripping force on the transfer sheet disposed therein.

Exemplary clamp **830** is shown in FIGS. **65** and **66**. Clamp **830** is another embodiment of the present invention. Clamp **830** includes large U-channel member **832**, small U-channel member **834**, cylindrical member **836**, a plurality of belt engaging elements **838**, and a plurality of cams **840**. Large U-channel member **832** displays outer surface **842**, inner surface **844** and defines a plurality of slots **846**. Each slot **846** is optionally configured with a horizontal and a vertical dimension. Small U-channel member **834** displays outer surface **848** and inner surface **850**. In this embodiment, U-channel members **832**, **834** are at least about 60 cm, preferably greater than about 100 cm, in length. Cylindrical member **836** has a circumference sufficient to enable cylindrical member **836** to fit within the confines of inner surface **846** with a transfer sheet wrapped therearound. Cylindrical member **836** may have a length substantially the same as U-channel members **832**, **834**. The outer surface of cylindrical member **836** may be smooth, but may also be somewhat rough, thereby further facilitating gripping, as described above. Belt engaging elements **838** are rigidly affixed to, and extend from, small U-channel member **834**. Disposed on each belt engaging element **838**, as part of cam attachment element **838**, is engaging means **852**.

In use, a portion of a transfer sheet (not shown) is wrapped around cylindrical member **836**. Cylindrical member **836** and the enwrapped sheet portion are disposed proximate inner surface **850** of small U-channel member **834** and adjacent belt engaging element **838**. Belt engaging elements **838** are then passed through slots **846**. Large U-channel member **832** and small U-channel member **834** are forced toward each other until cylindrical member **836** and the enwrapped sheet contact inner surface **844** of large U-channel member **832**. At this point, the vertical notch component of slots **846** has served as a passageway for cam attachment elements **854**. Cams **840** then lock members **832** and **834** together. Belt buckles or equivalent attaching means (not shown) are then affixed to belt engaging elements **838**. As in previous embodiments, when a transfer force is exerted on clamp **830**, members **832** and **834** are further forced together, thereby exerting an additional, or further, gripping force on the transfer sheet disposed therein.

Clamps **800** and **830** may be made from resilient, rather stiff materials. Suitable materials include various gauges of metal or synthetic resins. Buckle mechanisms, similar to those commonly used in automobiles, as well as the belts attached thereto, are possible for use as one embodiment of attaching means of the present invention.

Exemplary clamp **860**, depicted in FIGS. **67** and **68**, includes base member **862**, pivoting upper member **864**, two locking levers **866**, locking mechanism **868** and a plurality of belt attachment sites **870**. Pivoting upper member **864** pivots onto base member **862**, with a pivot site at the base of member **864** and coincident with locking mechanism **868**. A rubberized substance **869** or other material with increased tack may be present on the inner surfaces of base member **862** and upper member **864**. A pair of locking levers **866** is present atop base member **862** and proximate the pivotal end of pivoting upper member **864**. Locking mechanism **868** cooperates with locking levers **866** to secure pivoting upper member **864** in a locked position. Pivoting upper member **864** may be biased in an open position by such means as a leaf or helical spring. Two belt attachment sites **870** may be disposed adjacent to each locking lever **866**.

In practice, a portion of a transfer sheet (not shown) is disposed between base member **862** and pivoting upper member **864**. Alternatively, a portion of the transfer sheet may be wrapped around a cylindrical element or other suitable member (not shown), and then placed between base member **862** and pivoting upper member **864**. Pivoting upper member **864** is then pressed toward base member **862** until locking mechanism **868** locks, thereby securing base member **862** and pivoting upper member in a closed, locked position with the transfer sheet gripped securely therewithin. Alternatively, pivoting upper member **864** and locking levers **866** may be mechanically connected by a linkage or lever combination in which locking lever **866** is pressed down by a user, thereby forcing pivoting upper member **864** down until locking mechanism **868** securely locks base member **862** and pivoting member **864** in closed contact. Finally, belt or strap **872** is affixed to clamp **860** by disposing hook **874** within the slots located at belt attachment sites **870**.

As depicted in FIG. **68**, when transfer sheet **876** is secured within clamp **860**, base member **862** and pivoting upper member **864** are in a closed and locked position. When belt **872** is then retracted away from transfer sheet **876**, a transfer force is exerted onto transfer sheet **876** in the direction of arrow **880**. Due to the upper placement of belt attachment sites **870** and the angular configuration of the bottom portion of clamp **860**, a pivot point is thereby formed proximate locking mechanism **868**. This transfer motion simultaneously pivots upper member **864** upwardly and the portion of clamp **860** proximate hook attachment site **870** downwardly, thus rotating clamp **860** about the pivot point located proximate locking mechanism **868** and as indicated in arrow **880**. The angular orientation of the portion of transfer sheet **876**, secured within clamp **860**, relative to the remainder of transfer sheet **876** exerts a further gripping force thereon.

Patient transfer system **900**, as depicted in FIGS. **69–71**, broadly includes bed **902**, cart **904**, motor-winch unit **906**, perpendicular transfer units **908**, **910**, **912**, clamp **914** and a plurality of belts discussed below. Although depicted as cart

904, a bed or other horizontal surface may be used and still be within the spirit and scope of the present invention. Motor-winch unit **906** may be attached to base **916** of bed **902**. Perpendicular transfer unit **908** is attached to the upper frame of bed **902**. Another perpendicular transfer unit **910** is attached to the upper frame on adjoining cart **904**. Still another perpendicular transfer unit **912** is attached to the lower frame of cart **904**. As shown in FIG. **69**, a pair of belts **918** may extend generally upwardly from motor-winch unit **906** through perpendicular transfer unit **908**, finally extending horizontally on mattress **915**. Belts **918** are then attached to clamp **914** in any manner such as described herein. Alternately, belts **918** may proceed horizontally from motor-winch unit **906**, beneath bed **902** and cart **904** and through perpendicular transfer unit **912**. Extending generally upwardly and vertically from perpendicular transfer until **912**, belts **918** pass through perpendicular transfer unit **910**, then onto mattress **917**. On mattress **917**, belts **918** may be attached to a clamp such as a clamp of the present invention. Motor-winch unit **906** may be attached to bed **902** by means of rings **922** extending from housing **920**. Rings **922** may enclose an upper portion of casters **924** on which bed **902** is mounted.

In use, bed **902** and cart **904** are aligned and may be secured together. If a patient is to be transferred from bed **902** onto cart **904**, clamp **914** is attached to a transfer sheet upon which the patient is disposed. The belts attaching to clamp **914** have been routed under bed **902** and cart **904**, then upwards, and then horizontally by means of perpendicular transfer units **910** and **912**. Once motor-winch unit **906** is activated, belts **918** are retracted. The transfer force exerted thereby will transport the patient in the direction of arrow **926** from bed **902** onto cart **904**. Once the patient has been transferred onto cart **904**, motor-winch unit **906** is disengaged. Alternatively, a sensing device (not shown) may be attached to perpendicular transfer unit **910**. This sensing device may be either mechanical, electronic, magnetic, optical or a combination thereof in its operation and may detect the presence of the patient, the buckle, the belt portion proximate the buckle, or the clamp within a predetermined distance from perpendicular transfer unit **910**.

If the patient is to be transferred from cart **904** onto bed **902**, belts **918** are routed through perpendicular transfer unit **908** and onto mattress **915** where they are attached to clamp **914**. Clamp **914** is then securely attached to a transfer sheet upon which the patient is disposed. Motor-winch unit **906** is then activated, thereby retracting belt **918** in the direction of arrow **930**, thereby generating a transfer force upon clamp **914**. The transfer force acts upon the transfer sheet upon which the patient is disposed, thereby transferring the patient from cart **904** onto bed **902** and thereby further, or additionally, gripping the transfer sheet secured within clamp **914**. Again, patient proximity sensing devices may be included in perpendicular transfer unit **908** as discussed hereinabove. Perpendicular transfer units **908**, **910**, and **912** may include either a pulley system or a roller system onto which belts **918** are emplaced prior to a patient transfer. Clamp **914** may be any of the clamps disclosed herein. Some exemplary embodiments of motor-winch unit **906** are discussed in more detail herein.

Referring to FIGS. **72–74**, exemplary patient transfer system **940** is depicted. Patient transfer system **940** broadly includes bed **942**, portable transfer unit **944** and clamp **946**. Bed **942** includes mattress **948** and side rail **950**. Side rail **950** may include a plurality of horizontal bars **951**. Portable transfer unit **944** includes housing **952**, one or more belts **954**, an equal number of attaching means or buckles **956** and a motor-winch unit. Further included in portable transfer unit **944** is mounting bracket **958** which will be further described below. Handle **960** on portable transfer unit **944** enables an attendant to easily grasp and carry portable transfer unit **944** as desired. Housing **952** is preferably a light weight resilient plastic or other suitable light weight material. Portable transfer unit **944** has the advantage of being light in weight, hence readily transportable by an attendant of virtually any size and lifting ability with little likelihood of injury therefrom. Portable transfer unit **944** may weigh between about 20 and 35 pounds. Portable transfer unit **944** may also weigh between about 15 and 25 pounds.

FIGS. **73** and **74** depict two of many possible embodiments **966**, **968** of control units **966**, **968**. Control units **966**, **968** control the operation of exemplary portable transfer unit **944**. Controls **970** of control units **966**, **968** serve to operate portable transfer unit **944**. Control unit **966** may communicate with portable transfer unit **944** by means of electromagnetic radiation, more particularly by radio frequency, or by other means. Controls **970** include on/off simultaneous transfer power control **974** and left and right transfer actuator controls **976**, **977**. Control unit **968** communicates with portable transfer unit **944** by means of a cord or other suitable connecting means. The cord is mechanically and electrically attached to control unit **968** and may be disposed on a spool or other retaining means within portable transfer unit **944**. The spool may be biased so that cord **974** winds thereon when control unit **968** is released by the operator. Control units **966** and **968** may be housed in a recess contained within portable transfer unit **944** when not in use. An alternative to the control units of this patient transfer system is via voice actuation. Voice actuation would enable the patient to effect the patient's own transfer and to halt a transfer in progress if the need to do so arose.

FIG. **75** depicts another embodiment of a portable transfer unit according to the present invention. In this embodiment, shaft **978** extends laterally from housing **952**. By being exposed, shaft **978** facilitates mounting spools **980** thereon. Spools **980** provide means upon which belts **982** are wound. Since shaft **978** is exposed, each spool **980** may be easily and quickly detached from shaft **978** to facilitate cleaning and disinfecting shaft **978**, spools **980** and belts **982**.

Exemplary portable transfer unit **944'** is depicted in FIG. **93**. In this embodiment, receiving cavity **962** is formed in lateral portions of housing **952'**. A drive shaft (not shown) is disposed within cavity **962**. Spool **980'** may be reversibly mounted on the shaft drive. Belt **988** is routed through slot **963** so that buckle **956** may be used to engage a clamp. Cap **964** may be used to cover cavity **962**.

Referring again to FIGS. **72–76**, bed **942** and exemplary portable transfer unit **944** are depicted. Portable transfer unit **944** is secured to side rail **950** by means such as those described below. Bed **942** is then placed beside a bed or cart onto which a patient is disposed upon a transfer sheet. The transfer sheet is then secured proximate the patient with clamp **946**. Belts **954** are then extended from portable transfer unit **944** and attached to clamp **946**. Either control unit **966** or **968** is detached from portable transfer unit **944** and used to operate the motor-winch within unit **944** by means such as on/off controls **974**. Upon actuation of the motor-winch mechanism, transfer unit **944** begins to wind belts **954** and thereby move clamp **946**, the transfer sheet, and the patient toward transfer unit **944**. The motor-winch assembly may cease operation when the attendant operates control unit **966**, **968** or when an above-described sensing device functions.

During transfer, it is desirable that the longitudinal axis of the patient be generally parallel to the longitudinal axis of the bed or cart onto which transfer is to be effected. If not, the patient may not be transferred completely onto the bed or cart and may require further manual adjustment by the attendant, possibly obviating some of the advantages of this system. Thus, left or right transfer actuator controls **976**, **977** may be used. For example, if left control **976** is actuated, the belt **982**, attached toward the patient's head, continues to be wound and the other belt **982** either ceases to be wound or is wound more slowly. In a similar manner, when right control **977** is actuated, belt **982**, attached closest to the patient's feet, continues to be wound and the other belt **982** either ceases to be wound or is wound more slowly.

When patient transfer is complete, patient transfer system **940** may be disengaged from the transfer sheet and detached from bed **942**. Belts **954** may then be retracted until attached clamp **946** is proximate portable transfer unit **944**. Control unit **968** (or **966**) is then stowed within a niche in portable transfer unit **944**. The attendant then grasps handle **960** and carries portable transfer unit **944** and attached clamp **946** to another location (FIG. **95**), or shows the unit on the cart or bed for subsequent use.

Exemplary portable transfer unit **984** is depicted in FIG. **76**. In this embodiment, belt **986** is bound onto spool **988**. Spool **988**, in turn, is detachably mounted onto bracket **990**. Bracket **990** is mounted onto the back of housing **952**. Bracket **990** includes upper member **992** and lower member **994**. An automatic sensing and motor disconnect may be included in this, as well as other, embodiments. The sensing mechanism detects the presence of either the patient, the clamp, or the terminus of an attached belt. Upon sensing one or more of these, portable transfer unit **984** ceases to wind belt **988**, thereby stopping or easing (slowing) patient transfer.

The portable devices, as well as the other devices of the present invention, preferably also contain an automatic recording and/or display mechanism **998**, representatively shown in FIG. **77**. Mechanism **998** records each patient transfer event. Recording is via a printout on paper or other means. Recording may also comprise storage or transfer of relevant information electronically. The stored information may then be transferred to a computer or other device as desired. Relevant information with regard to a transfer event may include the time of day, the patient's number and name, the attendant's name and number, and the time length of the transfer event. Other items, such as motor performance and torque received by the motor-winch assembly, speed, acceleration, alignment, or other parameters of the patient or the clamp when transferring the patient may also be recorded.

Referring to FIGS. **77** and **78**, exemplary patient transfer system **1000** broadly includes bed **1002** and portable transfer unit **1004**. Bed **1002** includes mattress **1006** and side rail **1008**. Portable transfer unit **1004** includes housing **1010**, control unit **1012**, belts **1014** and an engaging mechanism, such as clamp **1016**. Belts **1014** and clamp **1016** may include any of the embodiments discussed herein. Portable transfer unit **1004** combines a housing which encloses the motor and winch assembly and which is easily and reversibly mounted onto side rail **1008**. Mounting bracket **1018** may be integral to housing **1010** of portable transfer unit **1004**. Mounting bracket **1018** readily and securely mounts onto side rail **1008**. A side view of one embodiment of mounting bracket **1018** is depicted in FIG. **78**. While shown as unitary to the embodiment of FIG. **77**, the concept depicted in FIG. **78** is applicable to any of the portable transfer units of the present invention. Mounting bracket **1018** includes engaging side **1020** of portable transfer unit housing **1010**, horizontal extension **1022** and substantially vertical member **1024**.

In use, portable transfer unit **1004** is situated onto side rail **1008** such that the lower surface of horizontal extension **1022** rests on side rail **1008**. Pin **1026** is then inserted in opening **1027**, extending through member **1024** and into a slot or receiving orifice **1028**, securely fastening therein. Mounting bracket **1018**, thereby securely holds portable transfer unit **1004** onto side rail **1008** during a transfer event. Moreover, transfer unit **1004** is easily detachable from side rail **1008** by removing pin **1026**.

An end view of another embodiment of a portable transfer unit **1004'** is depicted in FIG. **94**, where an alternate mounting bracket **1018'** is disclosed. Mounting bracket **1018'** includes horizontal extension **1022'** extending integrally from housing **1010'**. Extending generally vertically from horizontal extension **1022'** are fixed upper vertical member **1030** and pivotally mounted, lower vertical member **1032**. A locking mechanism, actuated by cam lever **1034**, is included. To install portable transfer unit **1004** on a bed with side rails **1008**, portable transfer unit **1004'** is tilted, allowing upper vertical member **1030** to be disposed such that an upper side rail is between member **1030** and housing **1010'**. Lower vertical member **1032**, extended in an open position, allows portable transfer unit **1004'** to be disposed in position and lower side rails **1008** to be disposed proximate housing **1010'**. Lower vertical member **1032** is pivoted to a closed position, generally coaxial to that of upper vertical member **1030**. Finally, cam lever **1034** is pivoted into a locked position in the direction of arrow **1036**.

In FIGS. **79** and **80**, another embodiment of a self-contained portable transfer unit **1040** of the present invention is depicted. Portable transfer unit **1040** broadly includes handle-control unit **1042**, housing **1044**, clamp **1046**, belt **1048**, hook **1050**, and locking devices **1052**. Portable transfer unit **1040** is self contained, including a belt, clamp, and enclosed motor-winch assembly. The motor-winch assembly of portable transfer unit **1040** may be totally enclosed within housing **1044**. Belts **1048** may be extended to hook onto the framework of a bed or cart or they may be retracted to a position almost completely within housing **1044**. Locking devices **1052** may be embodiments previously discussed with respect to the clamps of the present invention. Handle-control unit **1042** may be detached during a transfer event. Handle-control unit **1042** may include controls **1056** disposed within housing **1058**. Alternatively, handle-control unit **1042** may include the controls depicted in FIGS. **73**, **74** and discussed hereinabove. Cord **1054** physically and electrically connects control unit **1042** to the remainder of portable transfer unit **1040**. Cord **1054** may be mounted to a pulley within housing **1044** so that cord **1054** is retracted unless pulled away by a user. Clamp **1046** may open downwardly to admit a transfer sheet therein.

In use, portable transfer unit **1040** is placed onto a bed, onto which a patient to be transferred is disposed upon a sheet. As shown in FIGS. **79–84**, locking devices **1052** are unlocked and the jaws of clamp **1046** are separated. A portion of the transfer sheet is placed between the jaws of clamp **1046**, the jaws are then closed and locking devices **1052** locked. Belts **1048** are extended away from portable transfer unit **1040**, across the bed or cart onto which the patient is to be transferred and hooks **1050** are hooked onto the bed frame. The attendant detaches handle-control unit **1042** and then begins the transfer by actuating the motor-winch assembly. When the patient has been transferred onto the desired bed or cart, the attendant turns the motor-winch

off. The transfer sheet is then freed from clamp **1046** and hooks **1050** are unhooked from the bed and retracted within housing **1044**. Finally, handle-control unit **1042** is reconnected to portable transfer unit **1040**. The attendant then may carry portable transfer unit **1040** away by grasping and holding handle-control unit **1042**.

In FIGS. **81** and **82**, other embodiments are shown for securing the clamps of the present invention. Referring to FIG. **81**, clamp **1070** is secured in a closed position by the operation of clip **1072**. Clamp **1070** includes lower pivoting member **1074** and upper clamp member **1076**. Clip **1072** includes free end **1078** and pivot **1080**. When in an open position, free end **1078** has been pivoted away from the body of clamp **1070** and lower pivoting member **1074** is pivoted away from upper clamp member **1076**. Functionally, a transfer sheet (not shown) is placed between lower pivoting member **1074** and upper clamp member **1076**. Lower pivoting member **1074** and upper clamp member **1076** are then pressed together. Free end **1078** is then pivoted toward the body of clamp **1070**, then snapped around the front thereof. A locking mechanism is thereby actuated, locking lower pivoting member **1074** and upper clamp member **1076** securely together and gripping the sheet therewithin.

Clamp assembly **1088** is shown in FIG. **82** includes clamp **1090** and locking assembly **1092**. Clamp **1090** further includes upper pivoting clamp member **1094** and lower clamp member **1096**. Locking assembly **1092** includes handle **1098**, which actuates the locking mechanism of clamp assembly **1088**. Handle **1098** is affixed to the remainder of locking assembly **1092** via an elongated member. Handle **1098** and the elongated member are slidable within slot **1100**. When clamp assembly **1088** is in an open position, upper pivoting clamp member **1094** is pivoted away from lower clamp member **1096** and handle **1098** is disposed toward rear edge **1102** of clamp **1090**. In use, a transfer sheet is placed between upper pivoting clamp member **1094** and lower clamp member **1096** and clamp members **1094**, **1096** are pressed together, firmly securing the transfer sheet within. Handle **1098** is then grasped by the attendant and pushed away from rear edge **1102**, thereby activating locking assembly **1092** and securing upper pivoting clamp member **1094** and lower clamp member **1096** together in a secure, closed position.

FIG. **83** is a side view of a self-contained portable transfer unit **1110**. Portable transfer unit **1110** may include any of the self-contained portable transfer units described herein. Included are upper clamp member **1112** and lower pivoting clamp member **1114**. When pivoted between an open and a closed position, lower pivoting clamp member **1114** may be moved in either direction as indicated by arrow **1116**.

FIG. **84** depicts self-contained portable transfer unit **1120**. In addition to other features described for the self-contained portable transfer unit embodiments herein, transfer unit **1120** includes upper pivoting clamp member **1122**, lower clamp member **1124** and housing **1126**. Venting **1128** is present within housing **1126**. As indicated by arrow **1130**, upper pivoting clamp member **1122** pivots upwardly toward an open position or downwardly toward lower clamp member **1124** when in a closed position. Venting **1128**, present in housing **1126**, facilitates air exchange and, consequently, enhances cooling of the motor-winch assembly within portable transfer unit **1120**.

FIGS. **85** and **86** disclose one embodiment of motor-winch assembly **1150** of the present invention. Motor-winch assembly **1150** broadly includes frame **1152**, upon which are mounted motor bracket **1154**, control board **1156**, hook member **1158**, right clutch bracket **1160** and left clutch bracket **1162**. Motor **1164** is operationally mounted on an upper portion of motor bracket **1154**. Gear **1166** (which in one embodiment is a 42-tooth gear) is attached to a shaft (not shown) extending from motor **1164**. Gear **1166**, in turn, operably engages gear **1168** which is mounted on shaft **1169**. Also mounted on shaft **1169** are right clutch **1170** and left clutch **1172**. Right clutch **1170** is disposed within right clutch bracket **1160**. Left clutch **1172** is disposed within left clutch bracket **1162**. Spring **1174** is disposed about right clutch **1170** and about left clutch **1172**. Spring **1174**, in turn, is enclosed by spring cover **1176**. Spring cover **1176** is attached to spring hub **1178**. A spring hub **1178** is affixed to right clutch bracket **1160** and left clutch bracket **1162**. Spool **1182** may be detachably disposed on the outboard portion of shaft **1169**. Motor-winch assembly **1150** is suitable for providing the necessary power to operate the transfer units described herein.

Optimized patient transfer requires smooth transition of the patient from one platform to another. One means for achieving such optimization is through use of a transfer bridge **1200**, shown in FIGS. **87–90**. A modified transfer bridge **1200'**, depicted in FIG. **87**, differs from transfer bridge **1200**. Transfer bridge **1200** broadly includes one or more sections **1202**. A stabilizer **1204** is ideally present on the underside of each section **1202**. Where multiple sections are used, such sections **1202** are joined by hinge **1206** (discussed hereinbelow), and stabilizer **1204** extends generally perpendicularly from each section. Functionally, transfer bridge **1200** is placed between a bed or cart onto which a patient is lying and another bed or cart onto which the patient is to be transferred. Stabilizer **1204** is disposed between the platforms, thereby securely holding transfer bridge **1200** in place and preventing transfer bridge **1200** from being displaced by patient contact during a transfer. After use, transfer bridge **1200** is folded along hinge **1206** for storage or transport.

One embodiment of hinge **1206** is depicted in FIG. **89**. Hinge **1206** may be manufactured as a "living hinge," i.e., a hinge made by removing a narrow, linear portion of the material along a portion of transfer bridge **1200** or transfer bridge **1200'**.

Transfer bridge **1200'**, shown in FIG. **88**, includes a plurality of sections **1202'** and a stabilizer **1204'**, mounted on the underside of each section **1202**. As in the case of transfer bridge **1200**, hinge **1206** is present and divides **1202**. Leading edge **1210** is present on the portion of transfer bridge **1200'** opposite stabilizers **1204'**. Although not depicted, transfer bridge **1200** and **1200'** may include one or more carrying handles. The carrying handles may be attachable, unitary to transfer bridge **1200**, **1200'** or may be cutouts within sections **1202** or **1202'**. Preparing transfer bridge **1200'** for a patient transfer is essentially done in an identical manner as preparing transfer bridge **1200**, the only exception being that leading edge **1210** is oriented toward the patient to be transferred.

Both transfer bridge **1200** and **1200'** may be constructed using a smooth polyethylene sheet material, which is generally about 1.5 millimeters in thickness. Alternatively, hinge **1206** may be reinforced with a thin sheet of polyethylene on the underside of transfer bridge **1200**, **1200'**. Stabilizer **1204'** may be centered about 7.5 centimeters from edge **1214**. One embodiment of transfer bridge **1200'** is about 31 centimeters wide at hinge **1206**, tapering to about 25 centimeters in width at each end. The cambered radius for a side section of transfer bridge **1200'** is about 105 centimeters. The cambered radius for the leading edge of transfer

bridge **1200'** is about 225 centimeters. The side camber insures that leading edge **1210** will firmly contact the mattress on which the patient is disposed such that transfer bridge **1200'** will not be displaced during a patient transfer. The leading edge camber allows for a gradually increasing amount of patient contact during transfer, rather than immediate total contact. The gradually increasing contact also tends to allow the patient to be pulled atop transfer bridge **1200'**, rather than abutting and possibly displacing transfer bridge **1200'**. Transfer bridge **1200'** is advantageously positioned when leading edge **1210** is placed under at least a portion of the patient.

In an average male patient, approximately 90% of the patient's weight resides in the portion between the patient's buttocks and shoulders. Hence, the overall length of transfer bridge **1200** or **1200'** should minimally provide support therefor. Accordingly, lengths for transfer bridge **1200** or **1200'** may be between 65 and 173, centimeters or about 65, 120 and 173 centimeters.

Clamp **1230** is yet another embodiment of an engaging means for use with this invention. Clamp **1230** is depicted in FIGS. **91** and **92**. Clamp **1230** broadly includes U-channel member **1232** and pivot assembly **1234**. Pivot assembly **1234**, in turn, includes pivot member **1236** and pivot rod **1238**. Defined laterally on each end of pivot member **1236** is pivot point orifice **1240**. Tab **1241** is laterally present proximate pivot point orifice **1240**. Symmetrically affixed to pivot member **1236** is a plurality of belt engaging elements **1242**. Each belt engaging element **1242** generally includes tongue section **1244** and planar member **1246**. Each tongue section **1244** defines engaging slot **1245**. Tongue section **1244** and planar member **1246** are joined in a stair step fashion. A pair of pivot rod brackets **1248** may be laterally attached to pivot member **1236** by means of a rivet or bolt. Orifice **1249** is defined by each pivot rod bracket **1248** and provides the opening through which pivot point **1240** may be disposed. At least one cylindrical member **1250** is affixed to each pivot rod bracket **1248**. U-channel member **1232** may include a plurality of slots **1252** and a plurality of brackets **1254**. U-channel member **1232** displays leading edge **1256** and inner surface **1258**, discussed hereinbelow. Mounted on brackets **1254** is a plurality of cam levers **1260** and springs **1262**.

Operationally, a portion of transfer sheet **1263** is wrapped about cylindrical member **1250**. Cylindrical member **1250** and the enwrapped portion of transfer sheet **1263** are then pivoted in the direction of arrow **1264** until brackets **1248** rest upon tabs **1241**. Slots **1252** on U-channel member **1232** are aligned with belt engaging elements **1242**. U-channel member **1232** and pivot assembly **1234** are then pressed together, thus allowing belt engaging elements **1242** to pass through slots **1252** and protrude forwardly therefrom. U-channel member **1232** and pivot assembly **1234** may be biased away from each other by means of a plurality of springs. Another alternative embodiment of clamp **1230** employs a spring (not shown) to bias cylindrical member **1250** in an open position. Cam levers **1260** are then rotated over pivot member **1236**, thereby biasing pivot member **1236** against U-channel member **1232** and cylindrical member **1250** firmly against inner surface **1258**. Finally, a belt buckle may be affixed to belt engaging elements **1242**. Leading edge **1256** of U-channel member **1232** is may be arcuate in cross-section, thereby allowing clamp **1230** to be more positively pulled upon a transfer bridge during a patient transfer, rather than abutting and displacing the transfer bridge.

Referring to FIGS. **96–97**, exemplary patient transfer system **1300** enables a single operator to transfer or reposition a patient disposed on a substantially pliable underlayment, such as a transfer sheet described herein. Patient transfer may be effected from a first horizontal surface to a second horizontal surface or from a first transfer position to a second transfer position. This invention may also advantageously and ergonomically reposition a patient disposed on a substantially pliable underlayment, for example, from a slumped position to a position more toward the head of the bed on which the patient is disposed. Embodiments of this invention may further enable a single operator to ergonomically roll or reposition a patient, for instance, from the patient's left side to the patient's right side (a rollover). Patient transfer is effected with minimum risk of back injury to the operator. Moreover, patient transfer system **1300** is compact, easily transported to and from the site of a transfer event, and self-contained.

Moreover, patient transfer system **1300** is compact and thus easily fits through hospital and elevator doors and other small spaces. A single attendant may easily roll patient transfer system **1300** to the site of a patient transfer, conduct the patient transfer, then roll patient transfer system **1300** to the site of another transfer or place of storage. Patient transfer system **1300** is self-contained in that every component necessary to transfer a patient disposed on a sheet from a first horizontal surface to a second horizontal surface is self-contained.

As seen in FIGS. **96–99**, **134**, patient transfer system **1300** broadly includes transfer caddy **1302**, transfer bridge **1304**, and transfer rod **1306**. Transfer caddy **1302**, in turn, includes head assembly **1308**, hook and web assembly **1310**, base assembly **1312** and electrical and switching system **1314**.

Referring to FIGS. **98**, **114**, head assembly **1308** includes top frame **1316**, power train **1318**, and upper shield assembly **1320**. Top frame **1316** includes front panel **1322**, base panel **1324**, motor bracket **1326**, retractor bracket **1328**, left clutch bracket **1330**, a pair of interlock switch brackets **1334**, and right clutch bracket **1336**.

Front panel **1322** includes lobes **1342** which extend laterally from upper edges of front panel **1322**. Lobes **1342** and front panel **1322** cooperate in defining generally rectangular openings **1344**. Front panel **1322** presents planar inner surface **1346**. Base panel **1324** extends generally transversely from a bottom edge of front panel **1322**. Base panel **1324** presents upper surface **1348**. A pair of laterally disposed peripheral lips **1350** extend upwardly from a rear edge of base panel **1324**. Arcuate extension **1352** is a rearward extension of base panel **1324** and is flanked by peripheral lips **1350**.

Motor bracket **1326** includes planar member **1354**, a lateral pair of generally perpendicular members **1356**, and generally perpendicular lower member **1358**. Motor bracket **1326** is affixed to top frame **1316**. More specifically, one of members **1356** is affixed to surface **1346** and lower member **1358** is affixed to surface **1348**.

Retractor bracket **1328** includes horizontal member **1362** and vertical member **1364**. Vertical member **1364** extends upwardly and generally transversely from horizontal member **1362**. A generally cylindrical or conical element **1365** extends from vertical member **1364** generally toward right clutch bracket **1336**. Retractor bracket **1328** is affixed to top frame **1316** slightly to the right and rearwardly from motor bracket **1326**. Motor bracket **1326** defines orifices **1366**, **1368**, **1370** and cutout **1372**. Orifice **1366** is defined generally centrally on planar member **1326**. Orifice **1368** is defined generally below orifice **1366**. One or more smaller orifices **1370** may also be defined within planar member

1354. Generally arcuate cutout 1372 may be defined proximate a central portion of an upper edge of member 1354.

Left clutch bracket 1330 generally includes inboard planar member 1376, outboard planar member 1378 and connecting member 1380. Front edges of inboard planar member 1376 and outboard planar member 1378 are unitary to connecting member 1380 and are joined at a bend in this embodiment. Inboard planar member 1376 defines central orifice 1382 and one or more smaller orifices 1384. Orifices 1384 may be peripherally disposed with respect to central orifice 1382. Outboard planar member 1378 defines opening 1388, cutouts 1390, opening 1392, cutout 1394, and generally rectangular opening 1396. Opening 1388 is generally circular, with four cutouts 1390 extending generally radially therefrom. Opening 1392 is defined above a rear portion of opening 1388. Generally arcuate cutout 1394 is defined proximate an upper edge of outboard planar member 1378. Rectangular opening 1396 is disposed generally centrally, below clutch opening 1388. A plurality of smaller openings 1398, flanking opening 1396, may also be defined by planar member 1378.

Interlock switch bracket 1334 is disposed proximate openings 1344 and affixed to front panel 1322 proximate surface 1346.

Right clutch bracket 1336 generally includes inboard planar member 1400, outboard planar member 1402 and connecting member 1404. Front edges of inboard and outboard planar members 1400, 1402 may be unitarily joined to connecting member 1404 at a bend. Orifices defined within inboard planar member 1400 and outer planar member 1402 are generally similar to those formed or defined by inboard planar member 1376 and outboard planar member 1338. Therefore, these openings are designated by identical numerals.

Motor bracket 1326 is mounted such that planar member 1354 is generally transverse to panels 1322, 1324. Inboard planar members 1376, 1400, outboard planar members 1378, 1402, and vertical member 1364 are disposed generally parallel to planar member 1354 in this embodiment.

Front panel 1322, base panel 1324, motor bracket 1326, retractor bracket 1328, left clutch bracket 1330, interlock switch brackets 1334, and right clutch bracket 1336 may be formed from a 16–18 gauge sheet metal. However, other suitable materials are known to the art.

Also as seen in FIGS. 98, 114, power train 1318 broadly includes motor 1410, motor gear 1412, shaft gear 1414, shaft bearing 1416, shaft 1418, and pluralities of magnetic clutch assemblies 1420, slip plates 1422, and drum assemblies 1424. Motor 1410 includes housing 1430 and motor shaft 1432. Motor shaft 1432 may define a key way (not shown). A generally coaxial bore 1434 is defined in motor gear 1412. Bore 1434 accommodates motor shaft 1432. Gear 1412 may be further affixed to motor shaft 1432 by means of a key (not shown) inserted in the key way. Motor 1410 may be affixed to motor bracket 1326 by fasteners, such as a plurality of screws. When motor 1410 is attached to motor bracket 1326 and motor gear 1412 is mounted on motor shaft 1432, motor shaft 1432 extends through motor orifice 1368 and motor gear 1412 is disposed outboard planar member 1354. When power train 1318 is assembled, shaft 1418 extends through orifices 1366, 1382, and 1388.

Shaft gear 1414 may be mounted on shaft 1418 in a similar manner as motor gear 1412 is mounted on motor shaft 1432. Shaft gear 1414 may further be disposed on shaft 1418 such that shaft gear 1414 meshes with motor gear 1412. Shaft 1418 extends through shaft bearing 1416 when power train 1318 is assembled. Shaft bearing 1416 may be further affixed to planar member 1354 by fasteners, such as a plurality of screws 1433. In one embodiment, gears 1412, 1414 respectively possess thirty-sixty and forty teeth. Gears 1412, 1414 may be formed from such materials as steel, cast iron, as well as from other materials known to the art. Shaft 1418 may be formed from similar materials as gears 1412, 1414. In this embodiment, motor 1410 is a permanent magnet, parallel shaft, DC brush gear motor, operating at 12 volts DC and generating approximately ⅛ hp. Also in this embodiment, motor 1410 rotates motor shaft 1432 at an output speed of between about 25 and 75 rpm and attains an output torque range of between approximately 300 in-lbs at 25 rpm and 100 in-lbs at 75 rpm. Motor 1410 may be approximately 10" (±0.5") long, 5" (±0.5") high, and 4" (±0.5") wide. An exemplary motor may be obtained from Byson Gear and Engineering Corporation, Downers Grove, Ill.

Each magnetic clutch assembly 1420 includes disk 1436 and cylindrical housing 1438. A generally coaxial bore 1440 extends through magnetic clutch assembly 1420. In this embodiment, bore 1440 has a ½" diameter and disk 1436 has a diameter of approximately 4.9" (±0.5"). Cylindrical housing 1438 has a diameter of approximately 4.2" (±0.5") and a height of approximately 1.8" (±0.5"). An exemplary magnetic clutch develops a torque of 22 lb-ft, and attains a coil power of 28 watts, an armature hub inertia of 161×10-4 lb-ft 2, a rotor inertia of about 172×10-4 lb-ft 2, and generates 3 hp at 1800 rpm. Disk 1436 may be mounted to an outboard surface of inboard planar member 1376 by fasteners, such as a plurality of screws. When magnetic clutch assembly 1420 is mounted to inboard member 1376, cylindrical housing 1438 extends through opening 1388. Magnetic clutch assembly 1420 is mounted such that shaft 1418 extends generally coaxially through bore 1440. Shaft 1418 and magnetic clutch 1420 may be affixed by a key way combination (not shown). Each slip plate 1422 defines bore 1466, a plurality of peripheral holes 1446, and presents an inboard surface 1444.

Each exemplary drum assembly 1424 includes cylindrical member 1450. Four threaded extensions 1452 may extend peripherally from cylindrical member 1450. Disk 1454 may be unitarily joined to cylindrical member 1450. Disk 1454 presents an outboard surface 1455 and defines a threaded aperture 1456. Cylindrical member 1457 coaxially extends from outboard surface 1455. Outboard disk 1458 extends generally coaxially and radially from the outboard terminus of cylindrical member 1457. Outboard disk 1458 defines an aperture 1460 and presents an outboard surface 1462. Aperture 1460 is generally aligned with threaded aperture 1456 in this embodiment.

Also in this embodiment, a fastener such as a screw extends through each aperture 1446 and is threadably disposed within each threaded extension 1452. Screw 1464 is extended through aperture 1460 and is threadably received within threaded aperture 1456 as will be discussed below. Bores 1466, 1468 are coaxially formed within slip plate 1422 and drum assembly 1424, respectively, such that shaft 1418 is received within bores 1466, 1468. Drag cap spring 1470 is compressibly held in place by drag cap 1472 cooperating with a fastener such as a screw. If a screw is used, the screw is threadably received within an aperture proximate a terminus of shaft 1418.

As seen in FIGS. 96, 98, upper shield assembly 1320 includes upper shield 1478 and respective left, and right end caps 1480, 1482. Upper shield 1478, in turn, includes front panel 1486, upper panel 1488, and rear panel 1490. Front

panel **1486** includes conical protrusion **1492**. Respective planar members **1493**, **1494** flank protrusion **1492** and present an interior surface **1496**. Lower lip **1498** extends generally transversely from interior surface **1496**, proximate a lower edge thereof. In this embodiment, upper panel **1488** includes planar member **1502** and presents upper surface **1504**. Planar member **1502**, in turn, defines switch aperture **1506**, on-off light aperture **1508**, and charge light aperture **1510**. Apertures **1506–1510** are generally and centrally aligned transverse a longitudinal axis of planar member **1502**. Rear panel **1490** includes respective left and right planar members **1514**, **1516**. Conical protrusion **1518** unitarily extends from, and is flanked by, left and right planar members **1514**, **1516**. An upper edge of rear panel **1490** unitarily joins a rear edge of upper panel **1488** at a bend. Upper and rear panels **1488**, **1490** cooperate in defining remote aperture **1522**. Remote aperture **1522** generally aligns with apertures **1506–1510** and extends downwardly into a portion of conical protrusion **1518**.

Another lower lip (not shown) protrudes from an interior surface of rear panel **1490** in a similar manner as lower lip **1498**. Extending from respective left and right edges of panels **1486–1490** are left and right peripheral extensions **1524**, **1526**, respectively. Extensions **1524**, **1526** are formed by inward recesses from the exterior edges of panels **1486–1490**.

Respective left and right end caps **1480**, **1482** are essentially mirror images in this embodiment. Hence, they will be described with like-numbered elements. Each end cap **1480**, **1482** includes an outboard member **1530**, an upper member **1532** and a rear member **1534**. Outboard member **1530** is generally arcuate in cross-section. Upper member **1532** further includes generally planar member **1536** and generally conical element **1538**. Element **1538** extends above a forward portion of planar member **1536**. Lip **1540** extends forward from a lower edge of rear member **1534**.

Referring to FIGS. **98**, **114–120**, hook and web assembly **1310** includes web **1550** and transfer hook **1552**. First and second loops **1556**, **1558** are formed within web **1550** by stitching **1560**. In this embodiment, transfer hook **1552** is a unitary structure, which includes strap retaining member **1564** and hook member **1566**. Strap retaining member **1564**, in turn, displays exterior surface **1565** and defines a generally cylindrical bore **1568**. A slot **1570** is further defined in a lower portion of strap retaining member **1564**. Extending from strap retaining member **1564** is flange **1572**. Flange **1572** displays lower surface **1573**. Hook member **1566** extends from an upper portion of strap retaining member **1564**. Hook member **1566** may be envisioned as including planar member **1574**, arcuate member **1575**, and terminal lip **1576**. Planar member **1574** extends from strap retaining member **1564**. Arcuate member **1575** extends from planar member **1574**. Terminal lip **1576** extends from arcuate member **1575** toward strap retaining member **1564**. Planar member **1574**, arcuate member **1575** and terminal lip **1576** display respective exterior surfaces **1577**, **1579**, **1581** and interior surfaces **1578**, **1580**, **1582**. Terminal lip **1576** displays tip **1583**. Viewed cross-sectionally in FIG. **120**, lines **1584**, **1585** represent sites on interior surfaces **1565**, **1580**. Plane **1587** extends through point **1585** and is generally perpendicular to surfaces **1578**, **1582**. Planes **1588**, **1589** extend through tip **1583** and line **1584** and are generally parallel to plane **1587**. Plane **1590** extends from surface **1578** and plane **1591** extends from surface **1582**. Gap **1592** is the distance between planes **1587**, **1588**; gap **1593** is the distance between planes **1588**, **1589**; and gap **1594** is the distance between planes **1590**, **1591**. Plane **1600** extends from surface **1577**. Plane **1601** extends from surface **1573** and is generally perpendicular to plane **1600**. Plane **1605** extends tangentially from the tip of flange **1572** and is generally perpendicular to planes **1600**, **1601**. Gap **1607** is the distance between planes **1587**, **1595**. Plane **1595** is generally perpendicular to surface **1577** and extends through a center of bore **1568**. Plane **1596** extends through the center of bore **1568** and bisects slot **1570**. Angle **1597** is formed by the intersection of planes **1595**, **1596**.

Exemplary transfer hook **1552** is about 4.03" (±0.05") in length and about 1.50" (±0.05") wide. Flange **1572** and members **1574**, **1576** may be respectively about 0.25" (±0.05") and 0.325" (±0.05") in thickness. Strap retaining member **1564** may be about 0.25" (±0.05") thick, but may be thicker proximate planar member **1574**. Respective gaps **1592**, **1593**, **1594**, **1586**, **1607** may be about 1.00" (±0.05"), 1.50" (±0.05"), 0.75" (±0.05"), 2.75" (±0.05"), 1.03" (±0.05"). Bore **1568** may be about 0.42" (±0.05") in diameter. Slot **1570** may be about 0.23" (±0.05") wide. Angles **1596**, **1603** may be about 20° (±10°) and 80° (±20°), respectively. Both terminal lip **1576** and flange **1572** may be rounded. If so, the edges of terminal lip **1576** may be rounded to a radius of about 0.50" (±0.05") and flange **1572** may be rounded to a radius of about 0.80" (±0.05"). In this embodiment, transfer hook **1552** is made from extruded aluminum.

Webbing **1550** connects to transfer hook **1554** by means of joint connector bolt **1598** and joint connector **1599**. Joint connector **1599** disposes within loop **1558**. Joint connector **1599** and loop **1558** are placed within bore **1568**. Webbing **1550** is extended through slot **1570**. To secure the attachment of webbing **1550** to transfer hook **1552**, joint connector bolt **1598** is threadably received onto joint connector **1599**. Dimensionally, exemplary web **1550** is about 60" in length and about 1.50" in width. However, it should be appreciated that the dimensions of web **1550** may be altered as necessary. Web **1550** may include materials suitable for automobile seat belts.

Hook and web assembly **1310** is installed onto drum assembly **1424** as depicted in FIGS. **117**, **118**. First loop **1556** is extended through opening **1344**. First loop **1556** is then aligned with apertures **1456**, **1460** (FIG. **98**). Screw **1464** is passed through aperture **1460** and first loop **1556**, then threadably received within aperture **1456**.

Exemplary base assembly **1312** is depicted in FIG. **99** and broadly includes leg assembly **1602**, vertical adjusting means such as actuator assembly **1604**, trunk and skirt assembly **1606**, handle assembly **1608**, and base shield assembly **1610**. Leg assembly **1602**, in turn, includes two front legs or bumpers **1622** and two rear legs or bumpers **1624** unitarily extending from central portion **1626**. A caster **1628** is attached to a lower surface of each bumper **1622**, **1624**. Central portion **1626** may display a generally planar surface **1630** which is recessed downwardly from bumpers **1622**, **1624**. Central portion **1626** further defines a plurality of recessed portions **1632**, used as discussed below.

Exemplary actuator assembly **1604** is shown in FIGS. **99**, **121** and includes actuator **1640**, left actuator support **1642**, right actuator support **1644**, plunger bracket **1646**, plunger pivot arm **1648**, actuator cable **1650**, and foot pedal assembly **1652**. Actuator **1640**, in turn, includes base member **1660**, actuator body **1664**, actuator piston **1666**, actuator pump piston **1668**, and disk **1670**. Actuator body **1664** extends generally transversely from generally horizontal base **1660**. The portion of actuator body above base **1660** is generally cylindrical. The portion of actuator body **1664**

proximate base **1660** houses a hydraulic reservoir and pump. Actuator piston **1666** is slidingly and coaxially disposed within an upper portion of actuator body **1664**. Pump piston **1668** extends from base **1660** generally transversely to actuator body **1664**. Disk **1670** is fixed to pump piston **1668** a distance away from a terminus of pump piston **1668**. Actuator cable **1650** includes a stiff, flexible wire element **1678** slidingly disposed within jacket **1680**. Further included are a plurality of fastening devices, such as ferrules **1682**.

Exemplary foot pedal assembly **1652** includes pedal bracket **1686**, a plurality of pedal levers **1688**, pedal pivot bearings **1690**, foot pedal **1692**, and foot pedal pad **1694**. Pedal lever **1688**, in turn, includes lever portion **1696**, pedal mounting bracket **1698**, and bearing mounting bracket **1700**. Pedal mounting bracket **1698** is disposed generally transversely to lever portion **1698** at a first end thereof. Bearing mounting bracket **1700** extends generally transversely from a second end of lever portion **1698**. Pedal bracket **1686** attaches to a lower surface of central portion **1626**. Pedal lever **1688** is disposed within pedal bracket **1686**. Each extension of bearing mounting bracket **1700** is disposed within a pedal pivot bearing **1690**. Each pedal pivot bearing **1690** is affixed to a lower surface of central portion **1626**. Foot pedal **1692**, in turn, is affixed to an upper surface of pedal mounting bracket **1698**. Foot pedal pad **1694** is then disposed atop an upper surface of foot pedal **1692**.

Referring to FIG. **99**, exemplary trunk and skirt assembly **1606** includes trunk **1710**, two hat sections **1712**, skirt plate **1714**, and skirt **1716**. Trunk **1710**, in turn, includes front panel **1720**, left side panel **1722**, right side panel **1724**, and rear panel **1726**. Front panel **1720** is a generally planar member. Left side panel **1722** and right side panel **1724** extend generally transversely from lateral edges of front panel **1720** and include a extended portions **1728**, **1729**. Extended portions **1728**, **1729** are generally rectangular in cross-section. Cord pocket **1730** is attached to an exterior surface of extended portion **1728**. Rear panel **1726** extends from rear edges of left and right side panels **1722**, **1724**. Rear panel **1726** includes planar member **1732**. Flange **1734** extends outwardly from an upper edge of planar member **1732**. Another flange **1736** extends from an exterior surface of planar member **1732**. Bracket **1738** extends rearwardly proximate a right edge of flange **1736**. In this embodiment, bracket **1738** is disposed generally transverse to planar member **1732**. Cutout **1740** is defined in a lower portion of rear panel **1726** in this embodiment. A cutout may also be defined in a corresponding location of front panel **1720**.

Each exemplary hat section **1712** includes base member **1744**, front vertical member **1746**, rear vertical member **1748**, and inboard vertical member **1750**. Front, rear and inboard vertical members **1746–1750** extend generally transversely from base member **1744** and join base member **1744** at a bend. A peripheral flange **1752** extends generally transversely from an upper edge of each of vertical members **1746–1750**. Inboard vertical member **1750** and an adjoining portion of base member **1744** cooperate to define an inwardly curved surface **1754**. Generally planar top skirt plate **1714** coextends with a mated pair of hat sections **1712** when trunk and skirt assembly **1608** is assembled.

Skirt **1716** includes front panel **1760**, left side panel **1762**, right side panel **1764**, and rear panel **1766**. Panels **1760–1766** are generally planar. Front flange **1768** and rear flange **1770** extend inwardly from top edges of front panel **1760** and rear panel **1766**, respectively. Front panel **1760** and rear panel **1766** further and respectively define cutouts **1772**, **1774** on lower-most portions thereof. A multiplicity of wear strips **1776** may be attached to exterior surfaces of panels **1760–1766**. In this embodiment, a wear strip **1776** is attached to lower portions of front and rear panels **1762**, **1766**, proximate cutouts **1772**, **1774**.

Actuator assembly **1604** and trunk and skirt assembly **1606** are assembled in a cooperative relationship as depicted in FIGS. **99**, **121**. Left and right actuator supports **1642**, **1644** are mated to actuator **1640** and then accommodated in one of recessed portions **1632** within central portion **1626**. Left and right actuator supports **1642**, **1644** are then affixed to central portion **1626** by threading screws into pre-drilled and pre-threaded holes therefor. Plunger pivot arm **1648** is then seated and pivotally affixed to a recessed portion **1632** on an upper surface of central portion **1626**. A portion of pump piston **1668**, disposed distally to disk **670**, is then mounted to an upper portion of plunger bracket **1646** by being disposed through a slot (not shown) defined therein. One end of wire **1678** is extended through an upper slot defined in plunger bracket **1646**. One of ferrules **1682** is then affixed to the end of wire **1678**. Trunk **1710** is then lowered into place atop central portion **1626**. Two hat sections **1712** are mated around actuator piston **1666** and affixed thereto by fastening means, such as a plurality of bolts threadably mated to nuts. Top skirt plate **1714** is then affixed to mated hat sections **1712** by fasteners such as screws or bolts through pre-drilled holes within top skirt plate **1714** and peripheral flanges **1752**. Top skirt plate **1714** and attached hat sections **1712** are affixed to lower surfaces of flanges **1768**, **1770** by such means as screws or bolts. The unattached end of wire **1768** is attached to pedal lever **1688** proximate pedal mounting bracket **1698** and secured thereto by a ferrule **1682**.

As also shown in FIGS. **99**, **121**, handle assembly **1608** includes a plurality of handle supports **1788** and handle **1790**. Respective holes **1792**, **1794** are defined in handle supports **1788** and handle **1790**. A first end of each handle support **1788** is accommodated in a recessed portion **1632** within central portion **1626** and affixed thereto. The free ends of handle **1790** then telescopically fit over exposed second ends of each handle support **1788**. Handle **1790** is then affixed to each handle support **1788** by such means as bolts or pins extending through holes **1788**, **1790**.

Exemplary base shield assembly **1610** broadly includes front base shield **1800**, rear base shield **1802**, and battery cover **1804**. Front base shield **1800**, in turn, includes front panel **1810**, left side panel **1812**, and right side panel **1814**. Left and right side panels **1812**, **1814** extend generally perpendicularly from lateral edges of front panel **1810**. Left side panel **1812** defines arcuate cutout **1816** proximate a rear edge thereof.

Exemplary rear base shield **1802**, in turn, includes rear panel **1822** and left and right panels **1824**, **1826**. Rear panel **1822** is generally outwardly curved in cross-section. Flange **1834** extends from an upper edge of rear panel **1822**. A lower portion of rear panel **1822** defines recessed portion **1836**. Recessed portion **1836**, in turn, defines cutout **1838** centrally proximate a lower edge thereof. A pair of laterally disposed handle moldings **1840** are formed proximate an upper and each lateral edge of rear panel **1822**. Rear panel **1822** defines bracket slot **1842**. Bracket slot **1842** is disposed such that bracket **1738** will extend therethrough when rear panel **1822** is in place. Left and right panels **1824**, **1826** extend respectively from left and right edges of rear panel **1822**. Left panel **1824** defines cutout **1848** proximate a front edge thereof and coordinate with cutout **1816** defined on left side panel **1812**. Label **1850** may be affixed to a predetermined portion **1852** of left panel **1824** in this embodiment. Label **1850** may display such indicia as operating and safety instructions.

Recessed edge **1828** extends from upper surfaces of panels **1810–1814** and **1822–1826**. A flange **1830** extends generally perpendicularly from lower edges of panels **1810–1814** and panels **1822–1826**.

Exemplary battery cover **1804** is unitary in this embodiment and includes rear panel **1860** and left and right panels **1862, 1864**. Rear panel **1860** may be envisioned as including left and right lobes **1868, 1870**. Curved surface **1872** presents vertical wall **1873**. Both curved surface **1872** and vertical wall **1873** are defined by lobes **1868, 1870**. In this embodiment, four generally vertical walls **1876** extend downwardly from rear panel **1860** to form pocket **1874** in an upper portion of right lobe **1870**. When battery cover **1804** is in place, plate **1878** is affixed to the bottom of pocket **1874**. Left and right panels **1862, 1864** extend generally perpendicularly from lateral edges of rear panel **1860**. Also when battery cover **1804** is in place, forward edges of left and right panels **1862, 1864** are proximate lateral edges of recessed area **1836**.

Referring to FIGS. **98, 99, 134**, the components of exemplary electrical and switching system **1314** broadly include charger **1902**, battery **1904**, AC sensor **1906**, logic board **1908**, interlock switches **1910**, proximity switches **1912**, remote coil assembly **1914**, remote switch **1916**, hour meter **1918**, and panel **1920**. Charger **1902**, in this embodiment, receives AC current via power cable **1900** and converts the AC current to DC current for charging battery **1904** via power cable **1901**. Charger **1902** is protected by cover **1903**. Input ratings for charger **1902** may include 90–264 VAC, line frequencies of 47–63 Hz, and currents between 0.80 A–0.35 A. Output ratings for charger **1902** may include, an initial charge voltage of 14.7 VDC, an end of charge voltage of 13.80 VDC, a current of 2.0 A, and a switchover current of 160 mA. Battery **1904** receives DC current from charger **1902** to operate the electrical components of transfer caddy **1302**. Battery **1904** is held in place by bracket **1905**. In this embodiment, battery **1904** is a rechargeable sealed lead acid battery with an output rating of 12 V and a nominal capacity of 12 Amp-hours or more. Also in this embodiment, AC sensor **1906** senses whether charger **1902** is plugged into 110 VAC or 220 VAC. This sensing is relayed to logic board **1908**. A pair of interlock switches **1910** are present as indicated in FIGS. **98, 114**. In this embodiment, proximity switches **1910** are affixed to base panel **1324**, proximate left and right end caps **1480, 1482**. Proximity switches **1910** disable electrical and switching system **1314** when either left or right end caps **1480, 1482** are not in place.

As may be seen in FIGS. **115–116, 134**, another pair of proximity switches **1912** are disposed proximate each interlock switch bracket **1334**. Each proximity switch pair **1912** includes a pair of single switches **1926** and pivot **1927**. Each single switch **1926** within switch pair **1912** operates from a separate circuitry. Switches **1926** are actuated by pivot **1927**. Exemplary remote coil assembly **1914** feeds out or retracts cable **1928**.

Referring to FIGS. **100, 101, 134**, remote switch **1916** is in electrical communication with logic board **1908** via cable **1928**, and remote coil assembly **1914**. Remote switch **1916** includes bottom cover **1940**, top cover **1942**, membrane switch **1944**, and button assembly **1946**. A plurality of moldings **1952** and a segmented platform **1954** may be present in bottom cover **1940**. Top cover **1942** includes another plurality of moldings (not shown), each molding generally aligned with a molding **1952** in bottom cover **1940**. Top cover **1942** also defines switch opening **1960**. Switch opening **1960** is defined proximate platform **1954** when top and bottom covers **1940, 1942** are mated. Membrane switch **1944** includes planar member **1964**, conductor **1966** and tab **1968**. Conductor **1966** generally extends from planar member **1964**. Tab **1968** represents a dielectric extension of conductor **1966**.

Button assembly **1946** is unitary in construction in this embodiment, and includes left and right lobes **1972, 1974** and base **1976**. Left and right lobes **1972, 1974** are joined at base **1976** in this embodiment. In practice, membrane switch **1944** is electrically connected to logic board **1908** via cable **1928**. Membrane switch **1944** is then disposed on platform **1954** and button assembly **1946** is disposed atop membrane switch **1944**. Top cover **1942** is then mated to bottom cover **1940** and secured thereto by a plurality of fasteners, such as screws **1978**. Each screw **1978** extends through bore **1953** of molding **1952** and is threadably received within a complimentary molding formed in top cover **1942**.

Another advantageous feature of exemplary transfer caddy **1302** is a switch controlling clutches **1420** after transfer caddy **1302** has effected a transfer, repositioning or rollover. In a first switch position, clutches **1420**, hence drum assemblies **1424**, turn freely or unwind slightly, thereby enabling the operator to more easily disconnect transfer hook **1552** from transfer rod **1306** after a transfer or repositioning. In a second switch position, clutches **1420** are still engaged with slip plates **1422**, thereby preventing drum assemblies **1424** from turning freely and holding the patient in a new rollover position. In the second switch position, drum assemblies are then reversed when the patient has been secured in the new desired position. Such a switch may be present on remote switch **1916** or proximate power switch **1988** on upper surface **1504** of upper panel **1488**.

Referring to FIGS. **96–98, 134**, panel **1920** includes power switch **1988**, on/off light **1990**, and charge light **1992**. Electrical and switching system **1314** is activated or deactivated by toggling power switch **1988**. On/off light **1990** displays a green color when electrical and switching system **1314** is activated in this embodiment. Charge light **1992** displays an amber light when the available charge in battery **1904** is less than 11.7±0.1 VDC. Charge light **1992** displays a blinking amber light when battery **1904** is being charged by charger **1902**.

As seen in FIG. **134**, exemplary logic board **1908** includes terminals **2000–2016**.Terminal **2000** electrically connects logic board **1908** to left clutch **1420** and to one of redundant proximity switches **1926** of a first proximity switch pair **1912**. Terminal **2002** electrically connects logic board **1908** to right clutch **1420** and to one of redundant proximity switches **1926** of a second proximity switch pair **1912**. Terminal **2004** electrically connects logic board **1908** to motor **1410**. Terminal **2006** electrically connects logic board **1908** to charger **1902**, battery **1904**, and AC sensor **1906**. Terminal **2008** electrically connects logic board **1908** to panel **1920**. Terminal **2010** electrically connects logic board **1908** to right interlock switch **1910** and to another redundant proximity switch **1926** of second proximity switch pair **1912**. Terminal **2012** electrically connects logic board **1908** to remote switch **1916**. Terminal **2014** electrically connects logic board **1908** to yet another redundant proximity switch **1926** of first proximity switch pair **1912** and to left interlock switch **1910**. Terminal **2016** electrically connects logic board **1908** to hour meter **1918**.

Logic board **1908** controls and monitors the operation of transfer caddy **1302**. One function of the operation of logic board **1908** is controlling clutches **1420** and motor **1410** when a transfer event is in progress. Another function of logic board **1908** is monitoring the condition of battery

1904. Still another function of logic board 1908 is monitoring charging of battery 1904 by charger 1902. Yet another function of logic board 1908 is monitoring when charger 1902 is connected to an AC receptacle.

Logic board 1908 controls the operation of clutches 1420 in response to an operator pressing left or right lobes 1972, 1974 of remote switch 1916. Logic board 1908 also actuates motor 1410 when either of clutches 1420 is energized. Logic board 1908 discontinues operation of one of clutches 1420 when a corresponding one of switches 1912, 1914 is activated. The deactivated clutch 1410 is locked-out until remote switch 1916 is cycled off and then on to prevent "chattering" of the clutch when an end of travel is reached. "Chattering" occurs when clutch 1420 is turned off and the tension on web 1550 is thereby released, causing web 1550 to disengage flange 1572 from proximity switch 1912. An end of travel condition is reached when flange 1572 of transfer hook 1552 contacts pivot 1927, thereby engaging proximity switch 1912. Logic board 1908 further prevents operation of either of clutches 1420 or motor 1410 when either interlock switch 1910 is engaged. Either of interlock switches 1910 are engaged when an adjacent end cap 1480, 1482 is not in position. Logic board 1908 further prevents operation of either of clutches 1420 or motor 1410 when charger 1902 is connected to an AC receptacle. Logic board 1908 still further activates the event timer contained within hour meter 1918 when a current above 1A originates from motor 1410. A current above 1A arbitrarily indicates that a transfer is being performed.

Logic board 1908 also functions as a battery condition monitor. Logic board 1908 monitors battery voltage and activates yellow indicator light 1992. Logic board 1908 detects a condition wherein the voltage potential of battery 1904 is less than 11.7±0.1 VDC. Upon detecting this condition, logic board 1908 displays yellow light 1992 until battery 1904 is charged to above this level. If logic board 1908 detects a voltage potential below 11.7±0.1 VDC during a transfer event, there is sufficient energy still contained within battery 1904 to complete the transfer. Logic board 1908 monitors the condition of charger 1902. Logic board 1908 detects when current between charger 1902 and battery 1904 exceeds 0.1 Amps. A current exceeding 0.1 Amps is above the "trickle charge level" charger 1902 typically supplies when battery 1904 is in a charged condition. Logic board 1908 activates light 1992 in response to a current between charger 1902 and battery 1904 exceeding 0.1 A. Logic board 1908 further locks out activation of light 1990 until charging is completed.

When charger 1902 is connected to an AC supply, logic board 1908, via AC sensor 1906, detects this condition for a value between 90–250 Vrms (volt-root mean square). When a value between 90–250 Vrms is detected, logic board 1908 locks out further operation of motor 1410 or clutches 1420. Logic board 1908 further activates light 1990, thus indicating that charger 1902 is connected to an AC supply. If charger 1902 is connected to an AC supply and light 1992 is activated, light 1990 will not be activated until the charging process for battery 1904 is complete.

Power switch 1988 controls power to motor 1410 and clutches 1420. When switch 1988 is toggled to an on position, green light 1990 is activated, indicating that a relay has been energized. This relay (not shown) controls power output to motor 1410 and clutches 1420. However, power for the electronics within logic board 1908 is otherwise not controlled by switch 1988. Thus, the condition of battery 1904 may be continuously monitored.

Exemplary electrical and switching system 1314 may be configured so that between about 135 and 150 transfers may take place before charge light 1992 is illuminated, if battery 1904 is fully charged before initiation of transfers. Moreover, more than between about 200 transfers and 300 transfers may occur before battery 1904 is so drained of voltage that clutches 1420 disengage, thereby stopping the transfer process. More than between about 35 and 45 transfers may be effected between when charge light 1992 illuminates and when clutches 1420 disengage. Of course, these potential numbers of transfers would depend on factors such as the amperage of battery 1904 when fully charged, the weights of patients transferred, coefficients of friction between the transfer sheets, upon which the patients are disposed and the upper surfaces of transfer bridge 1304 and the surfaces from which and to which the patients are being transferred, and temperatures where transfer caddy 1302 is stored and used.

Transfer caddy 1302 may be about 36 inches wide, thereby enabling transfer caddy 1302 to be rolled through most hospital doorways. However, other embodiments of transfer caddy 1302 may be wider than 36 inches, yet be readily transportable through most doorways.

Another embodiment of the transfer caddy of this invention is depicted in FIG. 137 as transfer caddy 2350. Transfer caddy 2350 differs from transfer caddy 1302 in that handle 2354 is mounted on front and rear bumpers. In this embodiment, handle 2354 is mounted on respective left front and rear bumpers 1622 and 1624 in mounts 2356. Handle 2354 may be secured in mounts 2356 by such fasteners as pins, locking cam assemblies or nut-bolt combinations. Transfer caddy 2350 may further include pivotable handle 2360. Handle 2360 pivots up in the direction of arrow 2362 from a recess in left end cap 1480. Handle 2360 may be used singly or in combination with handle 1608 or handle 2354 in transporting and positioning transfer caddy 2350.

Another embodiment to handle 1608 and 2354 is shown in FIG. 138 as handle assembly 2370. Exemplary handle assembly 2370 includes upper section 2372, left lower section 2374, and a right lower section. Left lower section 2374 and the right lower section are joined to upper section 2372 by hinge assemblies 2378. Hinge assemblies 2378 are mounted such that upper section 2372 folds toward head assembly 1308. However, hinge assemblies 2378 may be mounted to enable upper section 2372 to fold away from head assembly 1308 and down as well. Upper section 2372 may be reversibly locked into an upright position by such means as pins and clip-pin combinations.

Transfer caddy 1302 may be proportioned such that webs 1550 are spaced apart about 26 inches on center. While spacings less than about 26 inches may produce satisfactory results, it becomes more important that the patient's center of mass be centered between webs 1550 as spacing therebetween decreases.

A transfer bridge, positionable between the horizontal surface on which the patient is disposed and the horizontal surface to which the patient will be transferred, is advantageously employed in the invention. Such an exemplary transfer bridge is depicted in FIGS. 108–110 as 1304. Transfer bridge 1304 includes left and right inboard sections 2102, 2104 and left and right outboard sections 2106, 2108. Each section 2102–2108 displays upper surface 2110 and lower surface 2112. Each section 2102–2108 is hingedly connected to one or more adjacent sections by means of bridgespines 2116. Each bridgespine 2116 includes a flexible low-friction material, such as Cordura®, laid proximate upper surface 2110 and a strip of enhanced friction material,

such as Neoprene, placed proximate lower surface **2112**, thereby sandwiching the material of each of sections **2102–2108** therebetween. The layers are then stitched together in a manner known to the art. Inboard sections **2102**, **2104** are joined together by bridgespine **2116** and include loops **2114**. Each loop **2114** may be 0.188" diameter elastic (commonly known as bungee) cord. Each loop **2114** may be approximately 1" in length. Each of sections **2102–2108** may include a material such as polypropylene overlaid with Cordova and reinforced Neoprene. The polypropylene may be 0.125" (±0.05") in thickness. A series of longitudinally oriented ribs **2118** may also be present on lower surface **2112**. In this embodiment, sections **2102** and **2104** and sections **2106**, **2108** are generally mirror images. Each inboard section may extend outwardly approximately 17.25" (±0.1"). Each outboard section may extend approximately 16.5" (±0.1"). The depth of each inboard section **2102**, **2104** may taper generally from a maximum proximate a central bridgespine **2116**. The maximum depth of sections **2102**, **2104** may be approximately 14.0" (±0.1"). In this embodiment, tapering continues on both the forward and rear edges. Exemplary transfer bride **1304** reaches a minimum depth of about 6.56" (±0.1") proximate each lateral edge of outboard sections **2106**, **2108**. Each exemplary inboard section **2102**, **2104** has a length of about 17.25" (±0.1"). Each exemplary outboard section **2106**, **2108** extends about 16.5" (±0.1"). Indicia, such as arrow **2120**, may be present on upper surface **2110**. In this embodiment, arrow **2120** points toward the patient to be transferred. However, other indicia may be present on surfaces **2110**, **2112** as well.

Referring to FIGS. **102–107**, exemplary transfer rod **1306** includes first section **2140**, second section **2142**, and cord **2144**. First and second sections **2140**, **2142**, respectively, include hollow rods **2146**, **2148**. Each rod **2146**, **2148** defines a generally coaxial bore **2150**. Bore **2150** is generally oval in cross-section. First section **2140** includes rod covers **2156**, **2158**. Second section **2142** includes covers **2160**, **2162**. Each section **2140**, **2142** also includes several rod caps **2166**. Each rod cap **2166** is generally oval in cross-section and defines opening **2168** therein. Each rod cap **2166** further displays a flat surface **2170** and a rounded surface **2172**. A plurality of lips **2174** generally extend transversely from a midpoint of each flat surface **2170**. Opening **2168** generally conforms to an outer cross-sectional geometry of rods **2146**, **2148**. Each transfer rod **1306** may further include a plurality of cord plates **2178**. In this embodiment, cord plate **2178** is generally planar and configures to a cross section of rods **2146**, **2148**. Cord plate **2178** may further define a plurality of openings **2180**. A plurality of O-rings **2184** may also be present and, if present, are disposed as described below. In this embodiment, each rod **2146**, **2148** is made of material which includes extruded aluminum. Each rod cover is extruded urethane overlaid with a material with a durometer, further enabling rods **2146**, **2148** to grip a sheet.

Prior to assembly, a rod cap **2166** is installed in each end of each rod cover **2156–2162**. Installation includes contacting each lip **2174** to an interior surface of each rod cover **2156–2162** until flat surfaces **2170** contact the end of each rod cover **2156–2162**. Rods **2146**, **2148** are then forced inside the assembled rod cover-rod cap combinations, for example by a hydraulic press, such that a gap **2188** is assured therebetween. Gap **2188** will accommodate transfer hook **1552** as discussed below. An O-ring **2184** is then inserted onto rod **2146**. Elastic cord **2144** is then installed within bores **2150** of rods **2146**, **2148**. Each end of cord **2144** is passed through each opening **2180** in a cord plate **2178**. A knot is then formed in each free end of cord **2144**, thereby holding cord plates **2178** in place by the resulting tension.

In this embodiment, rods **2146**, **2148** are about 27" (±0.5") and 20" (±0.5"), respectively, with a cross-sectional width of 1.5" (±0.007") and a cross-sectional height of 0.5" (±0.007"). Bore **2150** has a cross-sectional height of about 0.25" (±0.01") and a cross-sectional width of 0.75" (±0.01"). Rod covers **2156–2162** are about 17" (±0.5"), 10.5" (±0.5"), 14.38" (±0.5"), and 14.38" (±0.5"), respectively, with a cross-sectional width of about 2.0" (±0.03"), and a cross-sectional height of about 1.0" (±0.02").

When assembled, a free end of rod **2146** extends from first section **2140**. An inboard portion of rod cover **2160** does not contact rod **2148**. Thus, the free end of rod **2146** slidingly fits within rod cover **2160** and results in an assembled transfer rod **1306** of approximately 66" (±1.0") in length. Of course, other lengths for transfer rod **1306** are possible as well. Transfer rod **1306** may, for example, be between about 45 inches and 72 inches long. However, longer transfer rods tend to better distribute the loads generated by patients. Moreover, centering of patient mass becomes less important as transfer rods increase in length.

Assembled transfer rod **1306** is broken down for storage by separating sections **2140**, **2142** in the directions indicated by arrows **2192**, then by folding sections **2140**, **2142** together in the directions indicated by arrows **2194**.

FIGS. **122–132**, depict exemplary steps in a patient transfer using the lateral patient transfer system of the present invention. A patient is lying on a first support **2304**. Disposed between the patient and first support **2304** is sheet **2306**. The patient is to be transferred to second support **2308**. First support **2304** and second support **2308** display respective upper surfaces **2310**, **2312**. An attendant has previously transported second support surface **2308** and transfer caddy **1302** into the room. Second support **2308** has been positioned such that it angles away from first support **2304**, thereby providing working space for the attendant. The attendant has locked wheels present on first support **2304** where possible. The attendant has further withdrawn transfer rod **1306** from pocket **1874** and mated first and second sections **2140**, **2142**. Transfer caddy **1302** has been positioned on a side of second support **2308** opposite first support **2304**. Side rails on first and second supports **2304**, **2308** have been lowered, if present. Transfer rod **1306** is then placed atop sheet **2306** and centered to align generally with the center of the patient's body, as depicted by line **2314**. Sheet **2306** is untucked and folded over transfer rod **1306**. Transfer rod **1306** is rolled at least once toward the patient. However, transfer rod **1306** may be rolled until transfer rod **1306** and an enwrapped portion of sheet **2306** are as close to the patient as possible. Transfer bridge **1304** is then unfolded and placed under transfer rod **1306**. Transfer bridge **1304** is positioned such that the cambered edge is proximate the patient. Indicia such as arrows will point toward the patient to be transferred in some embodiments of transfer bridge **1304**. Each hook and web assembly **1310** is unrolled from transfer caddy **1302** and placed upon second support **2308**. Hooks **1552** are then emplaced about rods **2146**, **2148** and enwrapped sheet **2306** at gaps **2188**. Second support **2308** is then brought into contact with first support **2304** as depicted by arrow **2316** in FIG. **127**. First and second supports, **2304**, **2308** are then docked if possible. Also, wheels on second support **2308** are locked if possible. Finally, supports **2304**, **2308** may be adjusted such that surface **2312** is approximately 1 inch lower than surface **2310**. Transfer caddy **1302** is then positioned as close to second support **2308** as possible and aligned with the center of the patient.

The vertical height of head assembly **1308** is then adjusted by foot pedal **1692**. Head assembly **1308** may be raised by pumping foot pedal **1692** as shown by arrow **2315**. Head assembly **1308** may be lowered by depressing and holding foot pedal **1692** until head assembly **1308** is at the desired vertical height. The desired vertical height of head assembly **1308** is such that a distance H (FIG. **126**) is formed between webbing **1550** and surface **2312**. Distance H in this example is about 1 inch. A value of about 1 inch for distance H will result in stable contact between transfer caddy **1302** and second support **2308**. As seen in FIG. **113**, head assembly **1308** is raised or lowered as indicated by arrows **2313** by foot pedal **1692**. In this embodiment, head assembly **1308** may be raised a distance **2317** from its lowest position. Exemplary distance **2317** is about 11 inches (±2 inches). Alternately, an electric motor may be used to actuate raising and lowering head assembly **1308**, for example, by powering a hydraulic pump. If an electric motor is employed, foot pedal assembly **1652** would be replaced with an electric switch. Alternately, an electric switch could be mounted proximate switch **1506** on upper panel **1488**.

Returning to FIGS. **122–132**, the attendant then removes remote switch **1916** from remote aperture **1522** and withdraws a desired length of power cable **1928**. Left and right lobes **1972**, **1974** are depressed as needed until the slack in webs **1550** has been taken up and webs **1550** are taut. The transfer event begins when lobes **1972**, **1974** are depressed simultaneously and the patient begins to be moved atop transfer bridge **1304** and toward second support **2308**. The attendant may insure that transfer bridge **1304** is not displaced by holding transfer bridge **1304** until the patient is atop thereof. Once the patient has been transported generally to a center position on second support **2308**, the attendant discontinues depressing left and right lobes **1972**, **1974**. However, if for some reason the patient transfer continues past this point, a safety mechanism provided in transfer caddy **1302** will automatically discontinue the transfer.

As depicted in FIGS. **115**, **116**, transfer hook **1552**, transfer rod **1306**, and an enwrapped portion of sheet **2306** are being retracted toward head assembly **1308**. If the patient transfer is not discontinued by an attendant, flange **1572** will contact and displace pivot **1927**. Pivot **1927** actuates proximity switch **1912**, when displaced and thereby discontinues the transfer.

Once the patient has been transferred to second support **2308**, the transfer event is ended. Transfer hooks **1552** are disconnected from transfer rod **1306** and sheet **2306** is then unwrapped from transfer rod **1306**. Sections **2140**, **2142** of transfer rod **1306** are then separated and returned to their storage position on transfer caddy **1302**. Transfer bridge **1304** is removed, refolded, and returned to its storage position on transfer caddy **1302** as well. Side rails are then raised on second support **2308**, if present. Transfer caddy **1302** may be then rolled away and transported to another desired location.

The beginning and end of a patient transfer event are characterized by an advantageous feature of the present invention. Web **1550** is wound on drum assembly **1424** to effect the transfer. If drum assembly **1424** were directly connected to shaft **1418**, rather than to magnetic clutch assembly **1420**, the transfer would begin and end abruptly. That is, drum assembly **1424** would begin to wind and cease winding at full speed. Thus, an abrupt and potentially uncomfortable beginning and ending of the patient transfer event might occur. However, addition of magnetic clutch assembly **1420** and slip plate **1422** results in a more gradual acceleration and deceleration in the rotation of drum assembly **1424**. Hence, the patient transfer effected by the present invention begins and ends in gradually increasing rates of transfer.

Another embodiment of the invention is depicted in FIG. **135** as exemplary patient transfer system **2330**. Exemplary patient transfer system **2330** is similar to patient transfer system **1330** with the exception that extended bumpers **2334** are present in place of bumpers **1484**. As seen in FIGS. **98** and **135**, bumpers **2334** differ from bumpers **1484** by the presence of extended member **2338**. Extended member **2338** mates to front portions of left and right end caps **1480**, **1482**. Other features of bumper **2334** may be similar to those of bumper **1484**. Another embodiment of bumper **2334** is extendible and retractable within endcaps **1480**, **1482** in the direction of arrow **2340**. Bumpers **2334** may be extended or retracted by such means as a worm gear drive (not shown). Still another embodiment of bumpers **2334** includes a plurality of telescoping sections to comprise member **2338** (not shown). Normally, front bumpers **1622** are disposed beneath a bed so that bumpers **1484** can contact the bed frame. Extended bumpers **2334** are advantageous if front bumpers **1622** cannot be positioned beneath the surface on which the patient is to be transferred, because extended bumper **2334** may nonetheless contact the frame.

Alternate embodiments of transfer caddy **1302** are depicted in FIGS. **139–144**. These embodiments employ measures such as weights to enhance the stability of transfer caddy **1302** during a transfer event. Referring to FIGS. **139–141** transfer caddy **1302** is depicted as including weight **2390** mounted on upper surface **2388** of rear bumper (or leg) **1624**. In this embodiment one or more orifices **2392** extend from upper surfaces **2388** to lower surfaces **2394** of rear bumpers **1624**. Threaded apertures may be formed in weights **2390** to coincide with locations of orifices **2392**. Bolts are then extended through orifices **2392** from lower surfaces **2394** of rear bumpers **1624** and threaded into the threaded apertures in weights **2390**.

Referring to FIGS. **142–144**, weight **2398** includes central portion **2404** and respective front and rear extensions **2400**, **2402**. Weight **2398** is formed to conform to the peripheral contours of leg assembly **1602**. Central portion **2404** conforms to the periphery of central portion **1626** of leg assembly **1602**. Respective front and rear extensions **2400**, **2402** conform to peripheries of respective front and rear bumpers **1622**, **1624**. Orifices may be formed in weight **2398** to coincide with the locations of casters **1628** and to accommodate mounting bolts. In this embodiment, weight **2398** is mounted to the underside of leg assembly **1602** by mounting bolts extending therethrough and threaded into apertures formed in leg assembly **1602**. Casters **1628** may then be mounted through weight **2398** into leg assembly **1602**.

Weights **2390**, **2398** may be used singly or in combination with other weights or stability enhancing means. Moreover, weights such as **2390**, **2398** may be mounted by other mounting means such as glues and clamps. Exemplary weights **2390**, **2398** may include such materials as lead, cast iron, steel and other metal alloys. Furthermore, some or all of the desirable stability enhancing means achieved by exemplary weights **2390**, **2398** may be attained by forming all or part of leg assembly **1602** from the same heavier materials as used to form exemplary weights **2390**, **2398**.

Still other stability enhancing means include extending the length of bumpers **1622**, **1624** of leg assembly **1602**. Leading edges **2410** of front bumpers **1622** and trailing edges of rear bumpers **2412** are about 12.5 inches and 8.8 inches, respectively, from center point **2408** in exemplary

leg assembly **1602**. Increasing the distance between center point **2408** and leading edges **2410** would be more effective than increasing the distance between center point **2408** and trailing edges **2412**.

Referring to FIG. **136**, a pair of sheet gripping devices **2380** are shown. Each gripping device **2380** includes a pair of extended gripping members **2384** and a connecting member **2386**. Gripping member pairs **2384** work together in jaw-like fashion and grip a portion of a transfer sheet in a similar manner to several of the embodiments herein. Connecting member **2386** may include means to mate with another connecting member such as transfer hook **1552**. Alternately, connecting member **2386** may include means to allow web **1550** to attach directly thereto. In this embodiment each pair of gripping devices **2380** may grip a sheet portion of about 12 inches in length and a combined sheet portion of about 24 inches.

Referring to FIGS. **145–150**, one embodiment of a pliable underlayment for patient transfer and repositioning is depicted as transfer sheet **2450**. Transfer sheet **2450** includes mantle **2452**, one or more reinforced edges **2454**, and one or more attaching members **2456**. Reinforced edge **2454** may include a number of embodiments discussed below.

Each attaching member **2456** is attached to, and cooperates with, mantle **2452** to define a pocket **2459**. Each attaching member **2456** in this embodiment is attached to mantle **2452** by stitching **2462**. A plurality of slots **2460** may be formed proximate a lateral edge of each pocket **2459**. Exemplary pockets **2459** are about 22 inches in length and about 2 inches wide.

Transfer bar **2470** is used in conjunction with transfer sheet **2450**. Exemplary transfer bar **2470** includes first and second bar segments **2472, 2473**. However, other embodiments of transfer bar **2470** may be unitary or one-piece in construction. Transfer bar **2470** defines first and second ends **2474, 2475** and first and second slots **2476, 2477**. Exemplary transfer bar **2470** is proportioned, and first and second slots **2476, 2477** are spaced apart, such that slots **2476, 2477** are exposed when transfer bar **2470** is disposed in pocket **2459**. In one embodiment slots **2476,2477** are spaced apart about 24 inches on center and transfer bar is about one inch wide, one-fourth inch in depth, and 26¾ inches in length. While slots **2476, 2477** are shown generally centered in first and second bar segments **2472, 2473**, first and second slots **2476, 2477** may be offset as well. Offset slots tend to maintain transfer bar **2470** in a flattened position during a patient transfer or pullup, thereby decreasing the likelihood of transfer bar **2470** being bent. Slots **2476, 2477** are dimensioned to accommodate a transfer or repositioning hook such as hook **2480** or transfer hook **1552**. Slots **2460** are formed proximate pockets **2459** and are also proportioned to accommodate connecting members such as hook **2480** or transfer hook **1552**. Hook **2480**, in this example, may extend through slot **2460** and attach to transfer bar **2470** disposed therein.

Transfer sheet **2450** displays respective first, second, third, and fourth edges **2484, 2486, 2488, 2490**. In FIG. **145**, a plurality of pockets **2459** are depicted extending generally parallel to respective first, third, and fourth edges **2484, 2488, 2490**, corresponding to a patient's head and sides. FIG. **146** depicts a plurality of pockets **2459** extending generally parallel to respective third and fourth edges **2488, 2490**, corresponding to portions of transfer sheet **2450** normally flanking a patient. In FIG. **147** a plurality of pockets **2459** are depicted extending generally parallel to each respective first and second edge **2484, 2486**. Edges **2484, 2486**, respectively, correspond to edges proximate a patient's head and foot. While pockets **2459** are depicted as generally contiguous or adjoining in FIGS. **145–150**, pockets **2459** may be spaced apart as well.

In FIGS. **151–161** other embodiments of the substantially pliable underlayment of this invention are depicted. FIG. **151** depicts transfer sheet **2500**. Transfer sheet **2500** includes mantle **2502**. Mantle **2502**, in turn, includes reinforced edges **2504**, a plurality of generally elliptically-shaped slots **2506**, and respective first and second stitchings **2508, 2510**. In this embodiment, slots **2506** are defined within reinforced edges **2504**. Slots **2506** are configured to accommodate a connecting device such as transfer hook **1552**. A plurality of respective first and second stitchings **2508, 2510** is present within mantle **2502**. First stitchings **2508** extend generally obliquely (diagonally) from edges **2504**. Second stitchings **2510** extend generally perpendicularly to first stitchings **2508** and extend generally obliquely to reinforced edges **2504** as well. Other reinforcing means may be present within mantle **2502**, either in addition to stitchings **2508, 2510** or to the exclusion thereof. These reinforcing means include reinforcing fibers, woven into the material of mantle **2502**. These reinforcing means reduce distortion to transfer sheet **2500** to less than about 10% during a patient transfer, repositioning, or rollover event. These reinforcing means may further reduce distortion to less than about 8%. These reinforcing means may still further reduce distortion to less than about 5%.

Transfer sheet **2520** is depicted in FIG. **152**. Transfer sheet **2520** includes mantle **2522**. Mantle **2522**, in turn, includes reinforced edges **2524** and a plurality of generally elliptically-shaped slots **2526**. Though not depicted, reinforcing means such as stitchings **2508, 2510** may be present as well. Reinforced edges **2524** are partially formed and bordered by hems **2528**. Slots **2526** are bordered by stitching (not depicted) in this embodiment. Slots **2526** are configured to accommodate a plurality of grasping or connecting members such as transfer hook **1552** to accommodate other grasping members requiring wider sights of attachment.

FIG. **153** depicts another embodiment of the pliable underlayment of this invention as transfer sheet **2540**. Transfer sheet **2540** includes mantle **2542**, reinforcements **2544** and apertures **2546**. In contrast to previous embodiments, reinforcements **2544** surround each aperture **2546**, but do not form a continuous reinforced edge. Reinforcements **2544** cooperate with apertures **2546** to form reinforced, discrete connector points. These connector points function to accommodate gripping mechanisms for patient transfers, repositionings, and rollovers. While not depicted, reinforcing means as discussed above may also be present.

Referring to FIGS. **154, 155** another embodiment of the pliable underlayment of the present invention is depicted generally as transfer sheet **2560**. Transfer sheet **2560** includes mantle **2562** and a plurality of reinforced portions **2564**. A slot **2566** is defined within each reinforced portion **2564** in this embodiment. Adjacent reinforced portions **2564** cooperate to form reinforced edges **2568**. In this embodiment slots **2566** are configured to accommodate a grasping or connecting member such as transfer hook **1552**. In this invention, any of slots **2506, 2526, 2566**, aperture **2546** or any opening formed in a pliable underlayment such as any of the transfer sheets described above, may be bordered by such protective and reinforcing means such as grommets.

Another embodiment of the substantially pliable underlayment of this invention is depicted in FIG. **156** as drawsheet **2600**. Drawsheet **2600** offers the advantages of maintaining its shape during a transfer or repositioning event

when gripped by clamps or connected to connecting members. Drawsheet **2600** offers the additional advantage of including an absorptive means, whereby fluids from a patient disposed thereon are transmitted away from the patient. Thus, the absorptive means help keep the patient dry. Drawsheet **2600** offers the further advantages of being washable in normal laundering facilities and eliminating the expense and waste involved when sanitary pads are used to absorb fluids from a patient.

Drawsheet **2600** includes mantle **2602**. Mantle **2602** may include a plurality of layers. Exemplary mantle **2602**, as depicted in FIG. **157**, includes permeable layer **2606**, absorptive layer **2608**, drawsheet layer **2610** and impermeable layer **2612** and any combination thereof. Permeable layer **2606** overlays absorptive layer **2608**. Permeable layer **2606** may include fabrics which allow liquids to pass through to absorptive layer **2608** and which impart a sensation of comfort to a patient lying thereon. Permeable layer **2606** may include fabrics such as cotton, linen, various polyesters such as nylon and rayon, as well as various blends thereof.

Absorptive layer **2608** includes a substance which will absorb liquids, thereby wicking them away from a patient disposed thereon. Absorptive layer **2608** may also include an anti-microbial substance such as Microban® or Biocryl®. These or other anti-microbial agents (biocides) may be capable of killing BRSA bacteria, such as Staphylococcus aureus. An absorptive acrylic spun-laced fabric disclosed in U.S. Pat. No. 5,350,625, assigned to DuPont and incorporated herein by reference, is one example of a suitable material for absorptive layer **2608**.

Drawsheet layer **2610**, as depicted in FIG. **158**, is designed to impart a resistance to distortion due to forces applied during a transfer, repositioning, or rollover event. Drawsheet **2600** thus includes fabrics designed to minimize the "parabolic" effects otherwise occurring in sheets which fail to resist stretching or distortion. One means of reinforcing drawsheet layer **2610** includes stitchings such as **2508**, **2510** as described above. Materials used in drawsheet layer **2610** may include cotton, linen, and polyesters such as nylon, rayon or any blend thereof.

Impermeable layer **2612** is disposed exterior to drawsheet layer **2610**. Impermeable layer **2612** is impermeable to liquids, thus protecting an underlying mattress from fluids originating from a patient disposed thereon. Impermeable layer **2612** may also include materials which reduce friction as drawsheet **2600** is drawn across a bed. Vinyl or silicone applied to a nylon substrate are examples of friction-reducing materials. Impermeable layer **2612** may further include antimicrobial or antibacterial compounds.

As seen in FIG. **156**, absorptive layer **2608** may extend over a central portion of drawsheet **2600**. Absorptive layer **2608** may be disposed on drawsheet **2600** so that absorptive layer **2608** underlies the portion of the patient between the patient's waistline and thighs. Drawsheet layer **2610** in this embodiment, is about 60 inches wide and 72 inches long. Absorptive layer **2608** is about 33 inches wide and about 33 inches long. As seen from FIG. **157**, absorptive layer **2608** is generally centrally disposed on drawsheet layer **2610**. Permeable layer **2606** may extend to within approximately one foot of beaded edge **2604**. Layers **2606–2612** present a tapering to reduce the density of drawsheet **2600**, thereby reducing the thickness of any seam which may contact a patient disposed thereon. By tapering, it is meant that layers **2606–2612** are dimensioned so that their edges do not coincide. For example, the edges of permeable layer **2606** are disposed outside the edges of absorptive layer **2608**; the edges of impermeable layer **2612** are disposed outside the edges of permeable layer **2606**; and the edges of drawsheet layer **2610** are disposed outside the edges of impermeable layer **2612**. Tapering has the effect of reducing localized pressure on a patient's skin which a thick seam might otherwise impart. The reduced pressure on the patient's skin reduces or eliminates irritation. Methods of bonding layers **2606–2612** to each other include stitching.

Also seen in the cross-section depicted in FIGS. **157**, **159** are enhanced beads (beaded edges) **2604**. Enhanced beads **2604** may be hems which include doubled or rolled materials from drawsheet layer **2610**. Electrically conductive, yet flexible materials may also be included in beads **2604**. One advantage of enhanced bead **2604** is that drawsheet **2600** may be more securely gripped during a transfer or repositioning event.

Also depicted in FIG. **156** are exemplary conductors **2614**, **2616**. Conductors **2614**, **2616** extend. generally parallel to each other in a non-contacting fashion within absorptive layer **2608**. Conductors **2614**, **2616** further extend from absorptive layer **2608** to logic board **2618**. When absorptive layer **2608** is dry, the electrical potential between conductors **2614**,**2616** is not expressed. However, when absorptive layer **2608** contacts a sufficient amount of liquids with electrolytes, such as urine or perspiration, current flows between conductors **2614**, **2616**. The current originates in a battery such as a 12-volt battery (not shown). Logic board **2618** thereby detects a closed circuit and may transmit an electromagnetic signal to a receiver (not shown), in response, thus alerting an attendant that drawsheet **2600** should be changed. The electromagnetic signal may also be transmitted via a conductor, which may be present in enhanced bead **2604**.

Absorptive layer **2608**, or other layers **2606**, **2610**, **2612**, may also include sensors **2620**. Sensors **2620** may generally extend from absorptive layer **2608** to logic board **2618**. Sensors **2620** may be designed to monitor such phenomena as the patient's temperature and heartbeat rate. These and other vital signs may also be transmitted electromagnetically to a receiver for automated monitoring and recording.

An alternative embodiment of permeable layer **2606** changes color when exposed to perspiration or urine due to a change in pH, thereby further alerting attendants that sheet **2600** needs to be changed.

FIG. **159** depicts drawsheet **2630**, another embodiment of the present invention. Drawsheet **2630** includes permeable layer **2606**, absorptive-drawsheet layer **2632**, impermeable layer **2612** and beaded edge **2604**. Layers **2606**, **2632**, and **2612** are bonded together, and cooperate in a tapering fashion as described above, except that the material of **2632** serves the dual functions of layers **2608**, **2610** of drawsheet **2600**.

Referring to FIGS. **160**, **161**, yet another embodiment of the substantially pliable underlayment of the present invention is depicted as transfer or repositioning sheet **2640**. Transfer sheet **2640** includes mantle **2642** and beaded edge **2644**. Material from mantle **2642** is wrapped about substantially flexible member **2646** and hemmed against itself, thereby forming beaded edge **2644**. Beaded edges **2604**, **2644** are desirable for attachment by a connecting member such as several of the clamps discussed herein. Affixing means, such as stitching **2648**, is used to affix the overlapping portions of the material of mantle **2642** proximate beaded edge **2644**. Transfer sheet **2640** may further include reinforcing means as discussed above.

Because numerous modifications may be made to this invention without departing from the spirit thereof, the scope of the invention is not to be limited to the embodiments illustrated and described. Rather, the scope of the invention is to be determined by appended claims and their equivalents.

What is claimed is:

1. A substantially pliable underlayment for transferring, repositioning, or rolling a patient disposed thereon, comprising:

a substantially smooth mantle proportioned to accommodate at least a central portion of the patient's body comprising a top layer including a permeable material, a second layer including an absorptive material, a third layer including an impermeable layer and a bottom layer including a reinforced drawsheet;

an attaching structure operably adjacent the mantle; and

a reinforcing structure for imparting a resistance to distortion of the mantle in response to a force exerted on the attaching structure.

2. The underlayment of claim **1**, wherein the mantle comprises fabrics selected from the group consisting of linen, cotton, satin, muslin, flannel, polyester and any combination thereof.

3. The underlayment of claim **1**, wherein the absorptive layer has a smaller surface area than a remainder of the mantle and wherein the absorptive layer is disposed on a generally central position on the mantle.

4. The underlayment of claim **3**, wherein the absorptive layer is disposed such that a portion of the patient between the patient's waistline and the patient's thighs overlays the absorptive layer.

5. The underlayment of claim **1**, wherein the impermeable layer at least partially overlays the drawsheet layer, the absorptive layer at least partially overlays the impermeable layer, and the permeable layer at least partially overlays the absorptive layer.

6. The underlayment of claim **1**, wherein tie permeable layer, the absorptive layer, the impermeable layer and the drawsheet layer are tapered adjacent the periphery of the underlayment.

7. The underlayment of claim **1**, wherein the absorptive layer further comprises a spun-laced acrylic.

8. The underlayment of claim **1**, wherein the absorptive layer further comprises an antimicrobial agent.

9. The underlayment of claim **8**, in which the antimicrobial agent is capable of killing BRSA bacteria.

10. The underlayment of claim **1**, further comprising a plurality of electrical conductors.

11. The underlayment of claim **10**, wherein the electrical conductors are in electrical communication when the absorptive layer absorbs a quantity of liquid.

12. The underlayment of claim **10**, further comprising a logic device in electrical communication with the electrical conductors.

13. The underlayment of claim **10**, further comprising a sensor for monitoring the patient's vital signs.

14. The underlayment of claim **13**, in which the sensor monitors one or more of a patient's vital signs selected from the group consisting of heart rate and temperature.

15. The underlayment of claim **1**, wherein the attaching structure includes structures selected from the group consisting of a beaded edge, one or more pockets proportioned to accommodate a transfer rod, a plurality of grommets proximate the underlayment periphery, reinforced border including one or more apertures or slots and any combination thereof.

16. The underlayment of claim **15**, the beaded edge including a substantially pliable member enclosed and hemmed by the mantle.

17. The underlayment of claim **15**, in which the reinforced border includes a composite fiber.

18. The underlayment of claim **1**, wherein the attaching structure includes an attaching member attached to the mantle in a manner in which the attaching member and the mantle cooperate to admit a transfer bar therebetween.

19. The underlayment of claim **18**, in which the attaching member is substantially pliable.

20. The underlayment of claim **18**, in which the attaching member is disposed adjacent a lateral edge of the mantle.

21. The underlayment of claim **18**, in which an attaching member is disposed adjacent each lateral edge of the mantle.

22. The underlayment of claim **18**, in which a slot is present in the attaching member and accommodates a connecting member of a patient transfer and positioning system.

23. The underlayment of claim **22**, wherein the connecting member is a transfer hook.

24. The underlayment of claim **18**, wherein the transfer bar includes a first slot position approximately on a first end of the transfer bar and a second slot located on a second end of the transfer bar.

25. The underlayment of claim **24**, wherein the first and second slots of the transfer bar are offset from center on first and second ends, respectively.

26. The underlayment of claim **18**, wherein the transfer bar comprises a flexible material.

27. The underlayment of claim **1**, in which a distortion less than about 10% occurs when a patient is transferred or repositioned.

28. The underlayment of claim **27**, in which a distortion less than about 8% occurs when a patient is transferred or repositioned.

29. The underlayment of claim **28**, in which a distortion less than about 5% occurs when a patient is transferred or repositioned.

30. The underlayment of claim **1**, wherein the reinforcing structure further includes a multiplicity of first stitchings extending generally obliquely from each edge of the underlayment.

31. The underlayment of claim **30**, in which the first stitchings are generally parallel.

32. The underlayment of claim **30**, wherein the reinforcing structure further comprises a multiplicity of second stitchings extending generally obliquely from each edge of the underlayment and further extending generally transversely to the first stitchings.

33. The underlayment of claim **32**, in which the second stitchings are generally parallel.

34. The underlayment of claim **30**, wherein the reinforcing structure further comprises a multiplicity of reinforcing fibers.

35. The underlayment of claim **32**, wherein the reinforcing structure further comprises multiple reinforcing fibers.

36. The underlayment of claim **1**, wherein the reinforcing structure comprises a multiplicity of reinforcing fibers.

37. The underlayment of claim **36**, in which the reinforcing fibers extend generally obliquely from each edge of the underlayment.

38. The underlayment of claim **1**, wherein the drawsheet is approximately 60 inches wide and 72 inches long.

39. The underlayment of claim **1**, wherein the attaching structure includes one or more sets of two or more pockets, said pockets of each set are positioned parallel to each other and said one or more sets are positioned along one or more edges of the mantle.

40. The underlayment of claim **39**, wherein each pocket is adapted to receive a transfer bar.

41. A method of transferring or repositioning a patient disposed on a substantially pliable underlayment, the method comprising the steps of:

providing the substantially pliable underlayment, the underlayment comprising a substantially smooth and pliable mantle having a top layer including a permeable material, a second layer including an absorptive material, a third layer including an impermeable layer and a bottom layer including a reinforced drawsheet; an attaching structure operably adjacent the mantle; and a reinforcing structure for imparting a resistance to distortion of the mantle in response to a force exerted on the attaching structure;

attaching a connecting member to the attaching structure; and

exerting the force on the connecting member, the force being sufficient to displace the patient.

42. The method of claim **41**, in which the attaching structure includes a beaded edge and in which the connecting member is attached to the beaded edge.

43. The method of claim **41**, in which the attaching structure includes an attaching member cooperating with the mantle to form a pocket accommodating a transfer bar and in which a plurality of connecting members are attached to the transfer bar.

44. The method of claim **43**, in which the transfer bar defines a plurality of slots and in which the connecting members are accommodated by the slots.

45. The method of claim **43**, in which a plurality of slits are defined in the pocket and in which each connecting member is at least partially disposed in one of the slits when connected to the transfer bar.

46. The method of claim **43**, in which the attaching structure includes a reinforced portion of the mantle defining a plurality of openings and in which the connecting structure connects to at least one of the openings.

47. The method of claim **41**, in which the connecting member is a clamp and the clamp is attached to the attaching structure.

48. The method of claim **41**, in which the attaching structure defines a plurality of openings and in which the connecting member is plurality of hooks attached to the openings.

49. The method of claim **41**, in which the force is exerted by a plurality of pliable members attached to the connecting members and being wound by a transfer caddy.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,341,393 B1
DATED : January 29, 2002
INVENTOR(S) : Thomas W. Votel

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 54,
Line 2, please delete the word "including" and insert in its place -- includes --.

Column 56,
Line 19, after the word "is" please insert -- a --.

Signed and Sealed this

Twenty-seventh Day of August, 2002

Attest:

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

Attesting Officer